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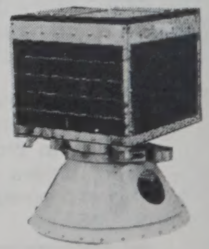

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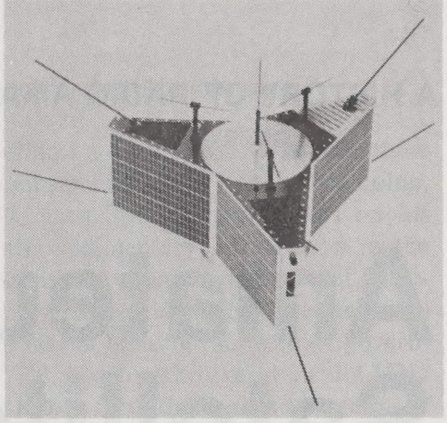

The Third Decade

*By Joe Kasser, G3ZCZ**

Twenty years ago Radio Amateurs thrilled to the announcement of an **O**rbiting **S**atellite **C**arrying **A**mateur **R**adio. OSCAR 1 launched on December 12, 1961, with the Discoverer 36 spacecraft, was designed and built by a group of Radio Amateurs in the San Francisco Bay area banded together as Project OSCAR, Inc. OSCAR 1 contained a battery powered beacon transmitter and radiated the Morse greeting, HI, HI on a frequency of 145 MHz until its batteries were exhausted. It weighed about 10 pounds and cost about $65.00 to build.

OSCAR 1 was the first of the Phase I series of spacecraft that demonstrated that Radio Amateurs could design and build working communications satellites. In the first decade Radio Amateurs put into operation the world's first multiple free-access communications satellite (OSCAR 3) and made the first direct satellite contacts between the USSR and the USA (via OSCAR 4).

The Radio Amateur Satellite Corporation (AMSAT) brought the Amateur Satellite Service into its second decade. Founded in 1969 in the Washington, DC area, AMSAT's first task was to put into orbit a satellite designed and built at Melbourne University in Australia. This spacecraft, the last of the Phase I series, known to history as AUSTRALIS-OSCAR 5, was the first Amateur built spacecraft capable of responding to ground commands. The AMSAT Phase II satellite program provided and continues to provide long life communications satellites in low-polar orbits. AMSAT-OSCAR's 6, 7 and 8 enabled many Radio Amateurs to expand their vhf/uhf horizons and affords a glimpse of the capability of an operational Radio Amateur Satellite Communications Network.

During the latter half of the second decade, planning and construction of a Phase III communications satellite was completed. The objectives of the Phase III program are to launch the operational era of the Amateur Satellite Service by providing global satellite coverage to at least 90 percent of the world's Radio Amateurs for many hours each day *using just one spacecraft*.

As we all know, the Phase III era was stillborn on May 23, 1980 when the Amateur Satellite Service suffered its first loss as the Ariane L02 rocket exploded seconds after leaving the pad. Phase III however still has a date with destiny as ESA has agreed to carry the Phase IIIB spacecraft aboard the Ariane L7 flight presently scheduled for February 24, 1982. This satellite, while being the first to show Radio Amateurs the capability of an operational worldwide communications satellite, is still far from the ideal of providing global coverage to everybody for 24 hours a day, and thus even though Phase IIIB is yet to fly, it is now time to start thinking about Phase IV.

Phase IV could provide global coverage to everybody 24 hours a day if the single satellite requirement is changed. If SYNCART packages are placed on three host space platforms in geosynchronous orbit, any Radio Amateur within line of sight of such a platform would be able to work anyone else who also is able to see the same platform. Each platform can see (and thus work) one third of the globe. Any lucky Radio Amateur able to see two such SYNCART's would be able to work two thirds of the globe directly. Consider for example three platforms located in geosychronous orbits above longitudes 75 °E (Indian Ocean), 200 °E (Pacific Ocean) and 330 °E (Atlantic Ocean) (See Fig. 1 on page 6 of *ORBIT* Number 1). With such a system, Europe and most of Africa can work both the Atlantic and Indian Ocean SYNCART's, Japan can work the Indian and Pacific Ocean ones while much of the USA can work both the Pacific and Atlantic Payloads. This scheme gives everybody communications capability over at least one third of the world, possibly more for 24 hours a day with 100 percent reliability. A quick glance at the world map shows that if these SYNCART packages are interlinked, full global coverage is provided to each and every Radio Amateur using at the most one interlink. Thus India could work California by means of the Indian-Pacific SYNCART link. That same station in India would talk to New York via the Indian-Atlantic SYNCART link. The interlink capability would be provided by a ground transponder that would be situated in a location that can see two platforms at the same time. The actual location of the ground segment of the communications link will of course depend on the locations of the SYNCART's (space segment) and that will depend on the host platform.

As the required bandwidth is not available below 435 MHz, Phase IV will probably carry a Mode M transponder initially. The uplink will be about 1269 MHz, the downlink at 436 MHz. Each SYNCART will contain the equivalent of three Phase III passbands as shown in Fig. 1, separated by, and associated with guard band areas. At the center of the space segment is a passband designated for in-zone working. This passband is used by any station within range of a SYNCART to work any other one within range of the same SYNCART. At the low frequency end of the central pass-

(Continued on page 12)

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*Editor, *Orbit* Magazine.

A HISTORY OF RADIO AMATEURS IN SPACE — PART I

Amateur Radio Satellite Experiments in the Pre-OSCAR Era

By Ray Soifer, W2RS*

For most of us, amateur satellite communications began with the launch of AMSAT-OSCAR 6 in 1972. For some, with the launch of OSCAR 3 in 1965; for others with OSCAR 1 in 1961. For a few of us, however, the real beginning came in October 1957. The author, then K2QBW, was a fourteen year old schoolboy home in bed with influenza when a banner headline in the *New York Times* brought the electrifying news that the Soviet Union had launched the first artificial earth satellite. Even better, it was transmitting on 20.005 MHz, and the cooperation of radio amateurs was being solicited because the existing Navy tracking network (there was no NASA in those days) was set up for the U.S. satellite program on 108 MHz and could not be converted over to 20 MHz quickly enough. We got out of bed and put the Hallicrafter SX-96 receiver on 20.005 MHz. After some waiting, the unmistakable 'squeak, squeak' of Sputnik 1 came in, building to a quite respectable S-7. We jotted down the times of acquisition and loss of signal, and reported them via 80-meter CW to W3WV of the Naval Research Laboratory who was monitoring for the purpose. After several days, the government tracking network was up and running, and the need for amateur reports subsided. Yet, that Sputnik 1 QSL card sent directly from Moscow will always be among this writer's most prized possessions.

This article is the first of a series reporting the history of the Radio Amateur Space Program. This series, published in commemoration of the 20th anniversary of the launching of OSCAR 1, will cover all aspects of Amateur Radio's involvement in space, including satellites, moon bounce, meteor scatter and the people involved. Readers having any input in the form of stories, anecdote, photographs, reminiscences, or anything else, please contact Joe Kasser, G3ZCZ, Box 27, Washington, DC 20044 or phone (301) 622-2194 to discuss your contribution.

Ionospheric Effects

Among the many amateurs who listened to Sputnik 1 were some professional ionosphere physicists and radio astronomers. For them, the world's first long-lived transmitter from above the densest layers of the ionosphere was a golden opportunity for research, and the papers soon came pouring out into the journals. It should be remembered that Sputnik 1 was launched during the highest sunspot maximum in recorded history, and ionospheric effects were quite pronounced at 20 MHz. In March, 1958, *Proceedings of the IRE* carried an item by W5LFL, then a graduate student at Stanford University and later a Skylab astronaut, reporting the frequent reappearance or enhancement of Sputnik 1's signal when the satellite was passing over the precise other side of the globe. 'Antipodal reception,' as this effect was called, was soon noted by many other observers, as was frequent long-range skip propagation and occasional blackouts from ionospheric disturbances. Still other papers demonstrated small variations, or scintillations, of the received frequency above and below the Doppler-adjusted mean, resulting from distortion of the satellite's signals as they passed through ionized regions. Literally, the signals from Sputnik were undergoing small refractions on the way down, each of which produced a slight change in the Doppler shift. Sputnik 2, launched a month after Sputnik 1, transmitted on the same frequency and experienced much the same effects.

Ionization Trail Reflection

Among the most respected of the Sputnik observers was Dr. J.D. Kraus, W8JK, of Ohio State University. The same March, 1958 issue of the *Proceedings* also

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*60 Waldron Ave., Glen Rock, NJ 07452

reported on some fascinating experiments by W8JK and his colleagues in which the signals of WWV, then located in Greenbelt, MD,† about 550 km from W8JK's laboratory, were observed to grow in strength at times corresponding to nearby Sputnik passes. These findings generated some heavy controversy, for they appeared to contradict much of what was thought to be known—a theme which keeps repeating itself in amateur radio history. As later reported in more detail in the *Proceedings*[1] and in the British journal, *Nature*[2], this effect did not occur all the time, but was sporadic, like meteor trail reflection. Through statistical techniques, WWV signal bursts were found to correlate very closely with satellite approaches. Today, we know that the upper ionosphere has many sporadic patches of intense ionization, often quite short-lived. When the satellite crossed one of these, a burst of WWV signal often resulted. These findings were further borne out by spectral analysis of the WWV signal returns, which showed Doppler shifts of not only the satellite velocity of 7 km/sec., but also smears of frequencies up to 40 km/sec. Doppler velocity, resulting from the interaction of the moving satellite with fast-moving corpuscular streams.

Communication via Ionization Trails

The articles by W8JK set the author to thinking. If WWV's signal could be propagated by reflection from a satellite's ionization trail, why not that of K2QBW? After all, 20 MHz, where the WWV experiments were being done, was not far removed from the amateur band at 21 MHz. By the time experiments could be set in motion, the author had enrolled as a freshman at M.I.T., and he started corresponding with Perry Klein, WA2ABC, who had recently moved to Maryland and received the call K3JTE. Tests were begun during school vacations in November, 1959, using the satellites Explorer 7 and Sputnik 3. Finally, on February 6, 1960, the letter 'N' in high-speed CW was passed both ways, signifying reception at each end of very weak signals from the other. No signal would have meant a 'T', and strong signals the letter 'M'. At the time of the two-way contact, the radiation experiment aboard Explorer 7 reported a large increase. Using statistical verification techniques, the probability that the K2QBW-K3JTE signals were *not* associated with satellite passes was shown to be less than one in a billion; the results were reviewed and approved by Professor Jerome B. Wiesner (later science advisor to President Kennedy and President of M.I.T.) and announced by M.I.T. to the press in March. Articles describing the experiment were published in *QST*[3] and in *Proceedings of the IRE*[4]. This accomplishment of amateur radio preceded by six months the first 'professional' two-way satellite communication using the passive reflector satellite Echo 1.

Orbital Tracking and Project Moonbeam

At this point, perhaps a brief pause. What did these amateurs know about satellite passes? At the beginning, of course, in 1957, each Sputnik-tracker was on his own. Using only the rudimentary information in the newspapers, each amateur kept his own record of reception times and, from these, estimated the next approach. Soon, help was at hand in the form of government radio staion VP0, which nightly on about 3.4 MHz broadcast the next day's fortieth-parallel intercepts of each satellite.

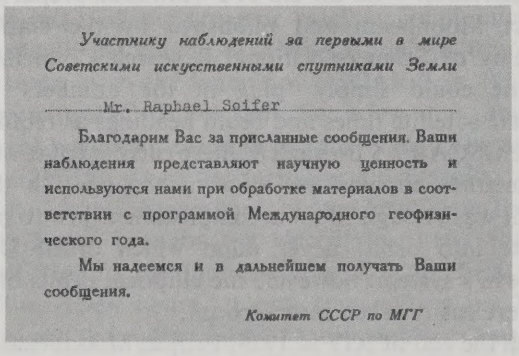
Still more help emerged from an enterprising Washington, D.C. lawyer and amateur astronomer named Norton Goodwin, who, in 1958, obtained a small government grant and launched Project Moonbeam as Project 30.21 of the U.S. effort for the International Geophysical Year. Project Moonbeam, a companion to the larger Project Moonwatch for optical tracking, sent out by mail to radio observers a weekly set of 'modified orbital elements' for each satellite, along with its frequencies, power and other characteristics. With the aid of a workbook prepared by Project Moonbeam and published by the National Academy of Sciences-National Research Council, the amateur could simply 'plug in the numbers' and calculate satellite times and beam headings as required. Unlike OSCAR's 5 through 8, these early satellite orbits were neither circular nor sun-synchronous. In those days, it was enough of an accomplishment just to put a satellite into orbit, never mind which orbit! Using Goodwin's system, however, the elliptical orbits of the day were easily taken into account.

With the end of IGY in 1959, Project Moonbeam was renamed the Volunteer Satellite Tracking Program. Later, in 1963, it became the Independent Tracking Coordination Program and its emphasis shifted toward providing data to sophisticated amateur astronomers. Accordingly, its tracking format shifted from modified orbital elements to the more sophisticated, but more complex, 'gear ratio elements' and it was gradually supplanted for amateur radio users by NORAD data released by the Goddard Space Flight Center. For five years, however, it was the main source of satellite tracking data for radio amateurs, and deserves an honored place in our history.

Office for Satellite Scatter Coordination

Response by amateurs to the K2QBW-K3JTE QSO, and to the articles which followed it, led the author to seek and obtain backing from the M.I.T. Department of Electrical Engineering to set up an ongoing program to assist those interested in experiments along similar lines. On March 1, 1961, the first bulletin of the new Office for Satellite Scatter Coordination (OSSC) was addressed to several dozen volunteers, and succeeding issues came out more or less monthly for the next few years.

Sputnik I QSL Card.



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Several groups of amateurs took up the offer of assistance. K3JTE, by then at the University of Pennsylvania, conducted a series of tests during the summer of 1961 with W3JXS, W3JXI, and K3IQU. During January 1962, K9GDQ and W9HHX made four contacts at 21 MHz and two more at 29 MHz, and in February K6HQJ and WA6JSA made contact on the west coast[5]. Dr. Bill Parker, G6BY, a retired physicist in Weston-Super-Mare, England, organized tests in the U.K. and was soon co-opted onto the Scientific Studies Committee of the RSGB.

As time went on, satellite launches proliferated to the point that the statistical verification techniques which had been used to demonstrate satellite-induced propagation were no longer usable. There were just too many objects in space.

Passive Detection of Silent Satellites

Drawing upon work they did at General Electric under an Air Force contract, K2OUX, W2YBP and K2LMG published an article in the July, 1959 *QST* on 'Radio Detection of Silent Satellites.'[6] The mechanism used was virtually the same as that developed by W8JK discussed earlier. W8JK had used his WWV signal strength recordings to track the re-entry of the first two Sputniks.[7] The three G.E. engineers further discussed their refinements in an article in the *Proceedings*.[8] The defense authorities expressed much interest in evaluating this technique. In August, 1962, the Office for Satellite Scatter Coordination was contacted by NORAD at Ent Air Force Base, Colorado, and asked to provide tracking reports using this technique on the imminent re-entry of Sputnik 4. Special arrangements were made to pass reports quickly to Colorado via military networks, and many reports were submitted from the U.S. and Europe, by OSSC member stations.

Although not a satellite experiment, K3JTE and his colleagues performed an extensive monitoring effort during the high-altitude nuclear explosion of July 9, 1962. The multi-megaton blast over the Pacific resulted in a severe blackout of HF propagation, with effects lasting up to 48 hours.

Project Echo

Echo 1, a balloon satellite of aluminized mylar about 30 meters in diameter, was orbited in August 1960 into a nearly circular orbit of about 1450 km altitude. Amateur VHF operators, most notably K2LMG and W0IC, then ARRL Rocky Mountain Division Director, had made unsuccessful attempts to bounce 144 MHz signals from it, with the best results achieved being a single 'dah.'[9]

In 1961, NASA announced a new program to launch a larger passive reflector, Echo 2, which would have a diameter of 40 meters and would be of improved construction. Unlike Echo 1, there would be no governmental communication program. Rather, private communication experiments would be encouraged by industry, research laboratories and the like around the world. The author contacted Professor Wiesner, who had gone to Washington to be science advisor to the new President Kennedy, and asked for his assistance in introducing OSSC and amateur radio to the Echo 2 project group at NASA. In November, a letter was received from Leonard Jaffe, Director of Communications Systems for NASA (and later a radio amateur himself), expressing warm interest. Mr. Jaffe introduced us to the Echo project manager, Mr. H.L. Eaker, and soon OSSC and ARRL were accredited experimenters in the Echo 2 project. Mr. Eaker and his staff provided a steady stream of helpful information. Gradually, the emphasis of OSSC shifted in favor of Echo 2 as the group's principal activity. At its peak in 1963, over 200 amateurs were on the OSSC list.

With the launch of Echo 2 on January 25, 1964, orbital information began to be carried over W1AW, in the same format as had been used for the two OSCAR beacon satellites. Echo 2 carried a beacon transmitter at 136 MHz, and W1HDQ described in *QST* how an existing two-meter converter could be used to receive it. Preparatory work done in advance of the Echo 2 launch by K2LMG, W2YBP and others covered ways of tracking the satellite with two-meter beams, the need for high angles of radiation, Faraday rotation problems and other subjects of interest to OSCAR users of today.[10]

The final results were less than spectacular. Weak signals were reflected from the satellite between W6DNG and W0IC, a ground distance of 1300 km, although a full two-way QSO did not take place. A computer program written at the time by K2LMG showed that Faraday rotation with a period of about two seconds had probably been responsible for the failure. Both stations used horizontal polarization.[11] Early hopes for better results as the satellite's orbit drifted towards earth also failed to materialize, as the balloon soon lost its round shape and with it, its uniform reflectivity.

Although not entirely successful, the Echo 2 effort did result in the development by many amateurs of stations and operating techniques that were to prove invaluable with the OSCAR 3 active-repeater satellite a year later. W0IC was among those making contact via OSCAR 3, as were many other Echo veterans. The Echo 2 experiments also marked amateur radio's first use of the new frequency allocation for space communications of 144-146 MHz, that had been made at the special Geneva ITU conference in 1963. This was also the first time that amateur radio was officially accepted as a participant in a NASA project (Project OSCAR had used military launch vehicles), a precedent which certainly did not hurt subsequent AMSAT relations.

AUSTRALIS-OSCAR 5: Sputnik Revisited?

Construction of a ten-meter beacon satellite by amateurs in Australia in the late Sixties inspired a *QST* article in November 1968, recalling the early experiments with antipodal reception and wondering whether similar ionospheric effects would hold this time.[12] Many observers, including the Australians, wondered out loud whether the ten-meter band was even usable as a satellite downlink. To those who remembered the strong, steady Sputnik signals on 20.005 MHz, such worries seemed pointless. Of course a VHF system would be more reliable, but a ten-meter downlink was so attractive in terms of the simple receivers and antennas required, and reliable enough for almost any amateur purposes, that a propagation experiment was organized in connection with the launch of AUSTRALIS-OSCAR 5 in January 1970. This was accomplished through the new Radio Amateur Satellite Corporation (AMSAT), of which K3JTE (later W3PK) was the founding president.

The results of this experiment, reported in October 1970, *QST*, showed that ten meters was indeed usable as a satellite downlink band.[13] Times of acquisition and loss of the ten meter signal were actually better than those of the companion beacon at two meters, and both skip and antipodal reception were also reported. Ionospheric disturbances, while absorbing some of the AUSTRALIS-OSCAR 5 signal and sometimes introducing scintillation effects, did not render the downlink unusable, particularly on CW. Just as amateurs had tracked Sputnik 1 with simple receivers and antennas, so too did they hear Australis-OSCAR 5 with wire antennas, whips and simple verticals as well as more elaborate beams. This was to be repeated thousands of times with AMSAT-OSCAR 6 and other later Phase II transponders.

Compared with the sophisticated uses planned for the Phase III satellites the experiments of 1957-70 seem, in retrospect, almost as ancient as those chronicled in *Two Hundred Meters and Down*. However, together with the efforts of Project OSCAR in California in 1959-65, they form an indispensable part of our roots as members of the Amateur Satellite Service. Those who lived through this period will always remember it.

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†The AMSAT Laboratory and the GSFC Visitor's Center now occupy the site.

Comets

Our Cover

Twenty years ago the Radio Amateur Satellite era was ushered in as OSCAR I rode into orbit aboard the launch vehicle carrying the Discoverer 36 spacecraft.

OSCAR I was designed and built by Radio Amateurs banded together as Project OSCAR, Inc. It transmitted telemetry for approximately three weeks before the internal batteries became exhausted. Signal reception reports were received from more than 600 radio amateurs in 25 countries. Our cover shows the beginning!

The Chopstick Helical

*By Colin Richards, 9M2CR**

A 70-cm high-gain antenna system for satellite work can be built from inexpensive materials. One innovative Amateur used chopsticks for supports.

The 70 cm satellite communications sub band is located between 435 and 438 MHz and optimal communications capability requires right-hand (clockwise) circular polarization. How to make a high-gain antenna with circular polarization, which can be hoisted into the air and pointed in the right direction without too much trouble is the question. Long-John Yagis crossed and phased could offer one solution: but at 435 MHz the phasing harness could present problems. Impedance matching is also a chore. So, why not a Helical? Here we have neatness, high gain, wide bandwidth and circular polarization all in one.

Scanning the handbooks for design information on Helicals showed that a ten-turn Helix looked promising: a gain of 15 dB would persuade my 10-watts output to masquerade as 300 watts, and a beamwidth of 36 degrees ought not be too finicky to point. The boom length at 435 MHz would be about six feet, with a reflector 28 inches square. These seemed like manageable dimensions. But what to use for the Helix, how to form it, how to keep it in shape? All pertinent questions at this particular QTH.

The boom was no problem. A six-foot, four-inch length of 1 x ½ meranti timber, good and straight, looked about right. Copper tubing is unobtainable: in any case it would have been expensive, heavy and difficult to shape. Someone, somewhere had mentioned using coaxial cable. RG58? The outer screen simulates a tubular conductor: the inner conductor is not needed but is soldered to the screen at each end. Good-grade coax has a tinned, close-mesh screen with an excellent weatherproof sheath.

Most handbooks show three spacers per complete turn of the Helix, each spacer set at a 120-degree angle to the last. Since the boom is rectangular, it is more sensible to opt for four spacers per turn, and to put them at 90-degree settings. The original plan was to use ¼ inch diameter plastic rod or wood dowel for the spacers, but nothing remotely resembling such material was available locally. Pondering the problem over a tasty meal of Fuyong egg, crispy chicken and Cantonese bean curd, I suddenly saw the answer there in my right hand: *chopsticks*! Why not?

Chopsticks are available in a wide variety of designs and material in Malaysia: I chose simple, wooden, everyday chopsticks (not bamboo), undecorated, sold in bundles of 20 for 25 U.S. cents a bundle. As with most chopsticks, the lower half is of circular, tapered cross-section merging into a rectangular shape for the upper half. It couldn't be better! The boom is marked at 1.7 inch intervals and drilled with holes 3/16-inch diameter consecutively at right angles for its entire length. The boom is long enough to allow three to four inches to stick through the reflector for clamping purposes. A 3.4-inch piece of the same boom material (1 x ½) was fixed to the boom at the reflector end, and the 1.7 inch intervals were measured from this. A drop of glue is put into each drilled hole and the chopsticks are pushed in one by one until they are wedged tight. Double-check to make sure that the sticks go in with a clockwise spiral (that is, from the back of the beam). When giving the final push, each chopstick is twisted so that the square sides are roughly in line with the path that the RG58 Helix would take. This makes it easier to file a small U-shaped depression at the top to allow the RG58 to sit in neatly. Chopsticks are generally about 10 inches long, and when pushed through the boom, about four inches protruded on the other side. These bits were carefully cut off. The Helix diameter is nine inches, so a mark is made on the last four spacers at each end of the boom at a point 4½ inches from the center line. A fine hole was drilled at these marker points, and thread strung along

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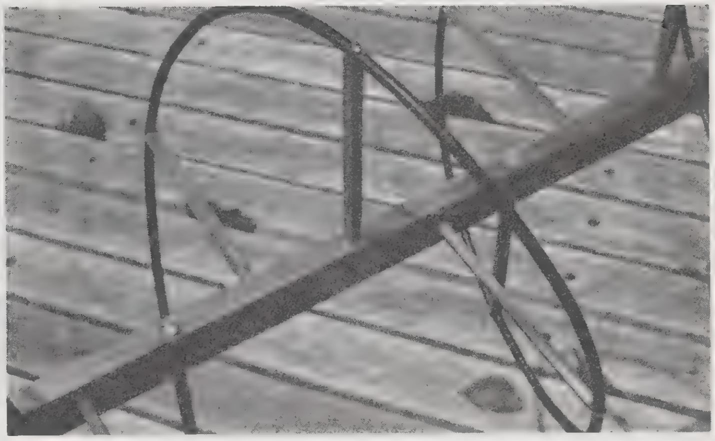

Chopsticks are used to hold the coaxial cable in place. Note the mounting technique for both the chopsticks and the cable.

from first to last spacer in each of the four rows. This enables the other spacers to be marked, to show where they should be cut off. After trimming, the tops are filed into a U-shaped depression in line with the Helix path. A small hole is then drilled an eighth of an inch below the tip so that a piece of waxed thread could be used to bind the RG58 Helix in place.

One end of the 25-foot length of RG58 is bared for half an inch, the sheath and dielectric removed, and the screen and center conductor twisted together and soldered. Starting with this end, the RG58 is bound to the short straight end section (3.4 inches) next to the reflector position. The soldered tip is placed so that it mates with the center terminal of an SO-239 socket which is mounted on the back of the reflector. The RG58 Helix is then wound carefully around the spacers, one at a time, binding in each spacer before moving to the next. In this way it is possible to assure that an even, circular spiral is created with no bulges or flat sections. As we neared the tenth turn, there was eight inches of RG58 left over. This is cut off, the end trimmed, and the outer screen and inner conductor soldered together. The thread bindings are touched with glue, and the boom and chopsticks are given a coat of clear varnish and set aside to dry.

The reflector comes next. Half-inch squared meshed screen is used, and a 28-inch square cut out and edged with ½ x ½ aluminum angle. A small, sturdy aluminum plate is used as a center mount for the reflector (it was, in fact, an old door-lock plate). An aperture 1 x ½ inch is cut in the center to allow the boom end to fit through and protrude four inches on the other side of the reflector. Above and below this aperture a hole is drilled for a 3-inch by ¼-inch coach bolt. The bolts are firmly screwed to the plate, with most of their length also protruding to the rear of the reflector. Two more lengths of aluminum angle (½ inch) are screwed across the plate in a vertical direction, to make the reflector rigid. The SO-239 socket is fitted to the plate, facing rearwards, with its center terminal lined up with the end of the Helix. The antenna boom is then pushed through the reflector mounting plate, carefully squared up, and fixed firmly in place with two stainless steel hose clips around coach-bolts and boom. The reflector weighs about eight pounds, whereas the antenna-plus-boom is only two pounds. A plywood bracket is fitted at the balance point, just a few inches from the reflector. Minor dents in the RG58 Helix are pushed gently into shape, and the Ten-Turn 'Chopstick' Helical is almost ready for hoisting aloft!

There still remains the question of matching to a 50-ohm feeder. The feed impedance of a Helical antenna of this design is near 140 ohms (this stays the same, by the way, regardless of the number of turns in the Helix). A quarter-wave matching section therefore, provides an impedance of about 84 ohms. The nearest coax is RG62, which has an impedance of 93 ohms. A quarter wavelength at 435 MHz is 6.8 inches and the velocity factor brings this down to 5.7 inches. (RG62 is partly air-spaced and the factor is 0.84.) After many 'cuts and tries', the SWR was brought down to 1.1:1.

Results? When used as an uplink antenna on OSCAR 7 Mode B, signal reports have been encouraging: and when used as a downlink antenna on Mode J, I can copy stations right down the horizon. I think it works!

The Phase-III IFDEM PSK Telemetry Beacon Demodulator

By John DuBois, W1HDX*

In his article 'Digital Communications Techniques and the AMSAT Phase III Satellites' published in the June 1979 issue of the *AMSAT Newsletter*, Karl Meinzer, DJ4ZC, has described the principles of digital data transmission methods for the Phase III beacon and presented some hardware designs for receiving this data.

In Dr. Meinzer's embodiment the beacon signal from the satellite (± doppler shift), is received by conventional SSB methods and appears as a baseband (audio) tone containing the phase shift data keying (PSK). In this form the data cannot be used directly and must be further processed to remove the differential bi-phase encoding before serial to parallel conversion. The AFDEM (Audio Frequency DEModulator) and BITREG (Bit-REGenerator) circuits presented by Dr. Meinzer fulfill these processing requirements and deliver separated 400 Hz clock and data for subsequent conversion to eight bit parallel data words.

PSK Demodulation

The choice of the audio range as the input spectrum for PSK demodulation in these designs was made for reasons of convenience in obtaining the signal output from the receiver for processing and because it is compatible with equipment which is present in a station equipped for SSB communication through OSCAR spacecraft. This however is not the only possible way to achieve telemetry demodulation of PSK signals.

In a series of tests conducted at W1HDX starting early in 1979 the AFDEM and BITREG circuits devised by DJ4ZC were used together with an audio frequency phase modulator to transmit and receive digital PSK signals through the AMSAT-OSCAR 7 spacecraft with conventional Mode-B SSB equipment. These tests involved transmission and reception of text as well as short character segments for the purpose of range determination. The protocol used was synchronous transmission at 400 baud without any systematic framing of character blocks except for the range tests which simply sent three characters for each range 'shot'.

These tests were the first use of the digital transmission techniques and circuits described in the DJ4ZC article through an OSCAR spacecraft. They proved extremely valuable in pointing out potential problems in operational service with Phase III missions. It was immediately apparent that receiver and/or transmitter tuning was extremely critical for stable reception of more than a few characters of data up to the AMSAT-OSCAR 7 spacecraft and back. (All initial tests involved only one station, that is transmission and reception were both at W1HDX.)

Further experimentation showed that this was due to characteristics of the AFDEM PSK demodulator which would tolerate only very slow changes in input frequency over a range of a few hundred cycles.

In the original DJ4ZC design, the PSK signal is modulated ± 90 degrees at the spacecraft and as transmitted contains no carrier. It resembles a DSB-AM signal in many ways and is in fact generated using a balanced modulator. We must obtain some clue at the receiver as to where the carrier was originally located in order to demodulate the signal. This is analogous to SSB reception and will already be a familiar concept to most amateurs. The problem is complicated in the case of digital data because whereas we can easily tolerate several hundred cycles of carrier re-insertion error in SSB voice reception, simple data demodulator circuits demand near absolute stability and accuracy of the local carrier frequency and phase for error-free detection.

Error-Free Detection

This requirement means that we must either know the carrier frequency and phase exactly in advance or if that is not possible, find some way to derive it from the carrier-less signal. An independent oscillator (e.g. a BFO) feeding a product detector in the receiver is just not good enough.

Keep in mind that we are discussing the treatment of the PSK signal after it has been converted down to some convenient frequency range such as the audio spectrum in DJ4ZC's organization. In this case the SSB product detector which delivered the PSK audio signal to be subsequently demodulated will normally be adequately stable. It just happens to be the last mixer in the receiver and is delivering an i-f output where the i-f center frequency is the center of the audio spectrum.

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Returning to the demodulation problem, the carrier is derived in the AFDEM circuit by taking the input signal spectrum which is audio frequencies over the range of 300 to 3000 Hz centered on approximately 1350 Hz and passing it through a highly non-linear circuit which is ideally a squaring circuit but is in this case an absolute value circuit. The spectrum emerging contains the original spectrum and a large number of intermodulation products extending up in frequency to several times the top of the original spectrum. In particular it contains a strong component at exactly twice the frequency of the original carrier and in correct phase relationship to the original modulation sidebands. This is caused by intermodulation of sidebands which are spaced symetrically about the missing carrier.

This is close to what is needed to recover the carrier except that it is twice the desired frequency, its amplitude is rather variable, and it is surrounded by numerous modulation and intermodulation sidebands. The AFDEM approach around these problems is to apply a bandpass filter of a few hundred cycle bandwidth at twice the carrier frequency so that the effect of the sidebands is diminished and then lock a phase lock loop (PLL) to it. The PLL voltage controlled oscillator (VCO) is then divided by two to obtain a reconstructed carrier at the frequency and phase of the original carrier for use in a product or other type of PSK demodulator.

Some Problems

Although this approach is excellent in theory, several factors cause a practical circuit to be difficult to use in the presence of doppler shift and noise, especially adjacent channel noise. If doppler shift is present on the original carrier, the bandpass filter must be as wide as the total shift expected otherwise the signal can shift out of the passband and the PLL will lose lock. However if one does use an adequately wide passband then the modulation sidebands and adjacent channel noise will pull the PLL phase unpredictably and cause a high error rate at the PSK demodulator.

Despite extensive experimentation with various AFDEM type circuits over several months in mid 1979, a suitable trade off between bandpass and PLL dynamics was not found. Although numerous circuits would work flawlessly on the bench with stable PSK generators, the moment a loop through the satellite was tried bit error rates increased to unacceptable levels (such as one error per bit).

The Costas Loop

On thinking about this problem one might say 'but the solution is obvious, just use a narrow bandpass filter in the AFDEM to track the carrier frequency or in this case twice the carrier frequency'. This is in fact the right path to an answer but before proceeding to a tracking bandpass filter of the kind used in electronic music, a search of the literature published in the field of telemetry revealed a very simple way of accomplishing the same result. It is called the Costas loop, which is a member of a class of circuits known as remodulation loops that are a combination of PLL and demodulator simultaneously. The Costas loop[3] was developed in the mid 1950's by John P. Costas at the General Elecric Company for use with double sideband suppressed carrier A-M systems. The purpose was to provide a simple but adequately stable means of deriving a local carrier for demodulation of these DSB A-M signals. Previous circuits were either more complex and expensive or required transmission of a pilot carrier which partially negated the advantages of the suppressed carrier scheme.

Since the purpose of the Costas loop is to derive a local carrier from a modulated but carrier-suppressed signal it would seem likely that it could be applied to a ± 90-degree PSK signal. This turns out to be true and it has been used with many PSK data telemetry systems, some of which are described in references 1 and 2.

The Costas loop can in theory be applied to a PSK signal at any frequency. If designed with the proper bandpass and time constants it will deliver demodulated data directly at the same time as it tracks the carrier. For the Phase III telemetry system 455 kHz was chosen as the input frequency since it is a common i-f output and the necessary 90-degree phase shift and input multipliers are simple at 455 kHz.

References

1. Spilker, J.J., *Digital Communications by Satellite*, Prentice Hall, 1977.

2. Gardner, F.M., *Phaselock Techniques*, John Wiley & Sons, 1977, second edition.

3. Costas, J.P., 'Synchronous Communications', *Proc. IRE*, December 1956.

Part II of this article will appear in a subsequent issue of Orbit. *Magazine.*

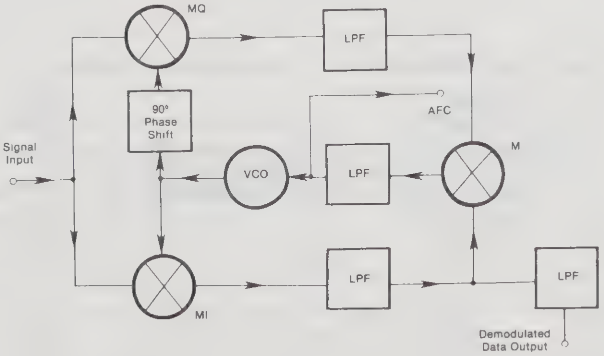


Fig. 1 — Block diagram for the Costas loop.

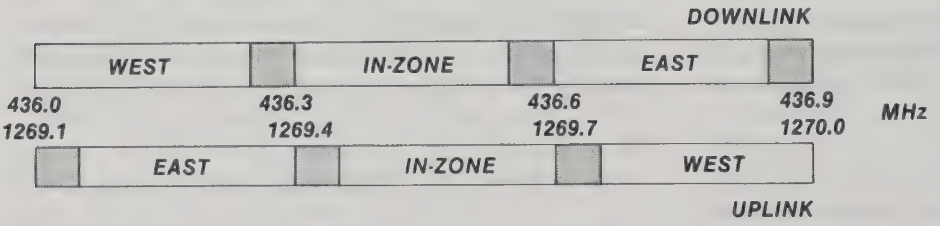
Off The Pad *(continued from page 3)*

band is another passband designated for interlinking to the west. This passband would be used by a station for a double hop QSO with stations not in his own zone, but in range of the SYNCART located to his west. A similar passband is available at the high-frequency end for double hop contacts with stations using the SYNCART to his east. Thus India would work New York via a double hop or space-earth-space segment link in the low passband, would work Europe via the single hop space segment (in zone) center passband and would work California via the double-hop high passband. The ssb/cw band plan for the occupancy of each subband would be identical and be based on the AMSAT band plan or percentage technique originally proposed by G3IOR and G3ZCZ for use with AMSAT-OSCAR 7 and later modified for Phase III. Since each SYNCART would provide effectively the same band of frequencies, *the band plan would be the same worldwide.* The ground segment would be an official AMSAT transponder station that would receive the interzone downlinks and transpose them to the relevant uplinks. This ground station would receive the West downlink of one SYNCART and reradiate it to the East uplink of the other, while transponding the East downlink of the second SYNCART to the West uplink of the first. Since the band plan is global, the ground segment stations can be identical reverse Mode M transponders.

Communicating through Phase III will be simpler than through Phase II, even though the downlink is expected to be 1½ S units weaker than that of the AMSAT-OSCAR 7 Mode B transponder and the uplink may require up to about 10 dB more transmitting power. Communicating through Phase IV is going to be even simpler, because the transponder will be available 24 hours a day and no tracking will be required.

The implementation of a Phase IV Radio Amateur Satellite Communications Network in no way precludes the Amateur Satellite Service from continuing to build and launch Phase II or Phase III types of spacecraft. That will depend on the constructional and launch capabilities available around the world. The day may yet come when a multiplicity of spacecraft are available in different orbits for various purposes much as the different hf bands are used for different purposes due to their different propagation characteristics.

Author's Note: This editorial was compiled while traveling in W6, W3, 4X, DL and G.



Note:

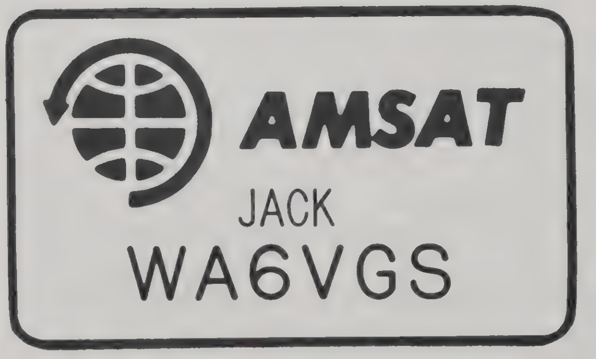
(1) Inverting passband

(2) Frequencies are tentative, not actual

(3) Guard area between passbands may contain beacon, command station, order wire, educational, scientific and other non-general communications signal channels.

Fig. 1 — An example of the proposed SYNCART passbands.

Comets



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Your donation of $5 or more to AMSAT will be appreciated and recognized with your own specially engraved AMSAT callsign badge. Actual size of the badge is shown at the left. This unique badge displays the AMSAT logo in metallic red; the AMSAT name in metallic blue with your name and callsign engraved to show blue with a white background.

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The ARSENE Project

The French viewpoint on the Radio Amateur Satellite program and their forthcoming satellite project.

The Amateur Radio Space Program in the United States has grown from an initial group of several NASA engineers (mostly at the Goddard Space Flight Center). These licensed Radio Amateurs put together the required administrative and technical base. They have been supported to a large extent by NASA which has provided space for their laboratories and a workshop at the Goddard Space Flight Center as well as equipment. The Department of Defense has supplied many of the parts necessary for the satellite including a kick motor to change orbit. NASA and the Department of Defense have shared launching the satellites into orbit, without charge. The Amateur Radio satellite was carried along as an "extra passenger." The worldwide interest in these satellites has led Americans to attempt to internationalize the project under their coordination, delegating parts of each project to groups outside of the United States (the English, Japanese for Oscar 8, Australians for Oscars' 5 and 7, and Germans for Phase III). In each instance these groups have established a supporting relationship with one of their universities or technical schools.

The Soviets have likewise orbited two Amateur Radio satellites (*radioloubiejnic spoutnik*) which were built by Amateurs with the support of the Soviet military and probably Soviet technical schools.

It seems, at least to one group of amateurs in *CNES* (National Center for the Study of Space in France) and *Industrie Aerospatiale*, that today, when France, the third power in space, is creating its own capability to orbit satellites (thanks to the Ariane) France should at the same time support Amateur Radio space activity which is such an advanced technical non-profit cause.

This idea was submitted to the directors of *CNES* at the end of 1978. All were extremely favorable to supporting the program provided that no financial commitment would be required. Thus, *CNES's* active support would consist of providing leftover parts and equipment from prior programs (which were not usable for future programs), permitting its employees to participate in the project, and finally helping to make appropriate tests preceding flights. They would also provide space on vehicles for missions not requiring the entire capacity of the Ariane. These missions of course, would themselves be completely financed by other sources.

Le programme spatial des radio-amateurs est dû à une initiative de quelques ingénieurs de la NASA (GSFC) eux-mêmes radio-amateurs. Ils ont créé les structures administratives et techniques nécessaires et sont fortement soutenus par la NASA (qui a attribué entre autres les locaux pour les laboratoires et ateliers au Centre Goddard et les équipements de base nécessaires), le DOD (Department of Defense) qui a fourni régulièrement des composants de satellites allant jusqu'aux moteurs de changement d'orbite, NASA et DOD se partageant les lancements (à titre gracieux en passager auxiliaire). L'intérêt mondial de cette activité a conduit les Américains à chercher une internationalisation sous leur contrôle, en délégant des tâches à des groupes étrangers (Anglais, Japonais pour OSCAR 8, Australiens pour OSCAR 5, Allemmands pour OSCAR 9) à charge pour ces groupes d'établir une relation avec un support tel qu'Université, Grande Ecole, Académie.

Les Soviétiques de leur côté ont également mis en orbite deux satellites (*radioliоubiejnic spounik*) réalisés par des radio-amateurs avec le soutien des militaires et sans doute de l'Académie des Sciences.

Il a semblé à un groupe de radio-amateurs du *CNES* et *de l'Industrie Aérospatiale* que la France, 3ème puissance spatiale, à l'heure où elle obtenait son autonomie de capacité de mise en orbite grâce à Ariane, se devait d'être présente dans ce type d'activité à caractère hautement technique et financièrement désintéressé.

L'idée soumise au Conseil de Direction de *CNES* y trouve dès la fin 1978 un accueil extrêmement favorable sous réserve que cette activité n'implique aucun financement de sa part. Son "parrainage actif" se traduirait par la mise à disposition de matériels provenant de programmes antérieurs et sans emploi pour des programmes futurs, par l'autorisation donnée à ses personnels de participer au projet sous forme de bénévolat et enfin par la réalisation des épreuves qui précédent un vol et le vol proprement dit en passager auxiliaire en profitant d'une mission qui n'utilise pas la pleine capacité d'Ariane, mission elle-mème financée par ailleurs.

Enfin la Direction du *CNES* a suggéré de soumettre cette idée aux Grandes Ecoles d'Ingénieurs formant les future cadres impliqués dans les activités

Finally, the leaders of *CNES* suggested that this idea be submitted to the French technical schools of engineers which are training the future leaders of the French space program.

All of these schools (*ENSAE, "Sup. Aero", ENS Telecom., ENS Telecom. de Bretagne, and ENS Techniques Avancees*) immediately and enthusiastically showed their support. Many students offered specific participation in their third year theses by devoting them to concrete, highly technical projects relating to the program.

Next, most of the French companies who are involved in the space program were approached and agreed to participate. As a first step (for two or three years) these companies will participate by employing and paying trainees from the schools mentioned above and then permitting them to work on matters arising in connection with the development project under the supervision of each company's own technical employees. At a later date, several have already offered to help complete various parts of the satellite as part of the practical training in their own educational programs.

Organization now being put into effect

The complexity of such a project is obvious since four different types of groups are involved both in the French mainland and overseas (including Kourou and probably Reunion Island as the telecommand stations for the satellite).

a) Amateur Radio operators,
b) a certain number of the technical schools,
c) *CNES*,
d) a certain number of industrial enterprises.

In order to have a legal body and base, the Amateur Radio operators who have been most involved have grouped together under a legal association called the "*Radio-Amateur Club de l'Espace*" ("RACE" - the Amateur Radio Club for Space) which was founded in January, 1980. The bylaws of this association were submitted to the Telecommunications Ministry for International Communication under which all Amateur Radio activities are governed.

Since all Amateur Radio operators are more or less involved, the French national association, the "*Reseau des Emetteurs Francais*" ("REF") with its 12,000 members, has also joined RACE.

The entire effort will be coordinated by a joint committee of the directors of the technical schools involved, the director of the space center in Toulouse (the space adviser working with *Sup. Aero.*) and president of RACE. Projects which are intended to be submitted to students or groups of students will be defined by a group of professors and Amateurs (who in general will be engineers working with *CNES*). A certain number of groups such as *CERT de l'ONERA* have proposed their assistance to evaluate, as work is being done, the quality of studies made and how they fit in with the overall objectives of the project. The detailed organization of the future phase for assembling the satellite will be studied spatiales.

L'accueil excellent réservé par les Directions des Ecoles (*ENSAE, "Sup. Aéro", ENS Télécom., ENS Telecom. de Bretagne, ENS Techniques Avancées*) a été immédiatement confirmé par l'enthousiasme de nombreux élèves attirés par la perspective de participer, au titre de leur thèse personnelle de 3ème année, à un projet concret de haute technicité.

La plupart des industriels impliqués dans les activités spatiales ont alors été approchés et ont accepté de participer au projet, dans un premier temps (la phase d'études qui durera 2 à 3 ans) en recevant (et en rémunérant) des stagiaires en provenance des Ecoles mentionnées et en les faisant travailler sur des sujets issus du Projet sous le contrôle de leur propre encadrement. Pour la deuxième phase de réalisation, certains ont déjà offert de faire réaliser diverses parties du satellite au titre des travaux pratiques de leurs écoles de formation professionnelle.

L'Organisation en cours de mise en place

La complexité d'un tel Projet est évidente puisqu'il met en présence quatre types d'entités réparties sur le territoire national (outre-mer compris en incluant Kourou et sans doute la Réunion pour les stations de télécommande du satellite).

les radio-amateurs,
un certain nombre de Grandes Ecoles,
le *CNES*
un certain nombre d'industriels.

Pour avoir une base juridique, les radio-amateurs les plus concernés se sont structurés en Association (loi de 1901): *le Radio-Amateur Club de l'Espace* qui commence à fonctioner depuis Janvier 1980. Les statuts de cette Association ont été remis à la Direction des Télécommunications du Réseau International (DGT/DTRI) qui gère les activités radio-amateurs.

Comme tous les radio-amateurs sont plus ou moins concernés, leur Association Nationale, le "*Réseau des Emetteurs Français*" (12,000 adhérants) a obtenu son adhésion au RACE en tant que personne morale.

L'ensemble sera coordonné par un Comité de Synthèse réunissant les Directeurs des Ecoles concernées, le Directeur du Centre Spatial de Toulouse (Conseiller Spatial auprès de *Sup. Aéro.*) et le Président du RACE. Les travaux destinés à être confiés à des élèves ou des groupes d'élèves sont définis par un Groupe de Projet formé de professeurs et de radio-amateurs (qui en règle générale sont ingénieurs au CNES). Un certain nombre d'organismes comme le *CERT de l'*ONERA ont proposé leur concours pour évaluer, au fur et à mesure du développement des travaux, la qualité des études et leur cohérence avec l'objectif poursuivi. L'organisation détaillée de la phase de réalisation sera étudiée dans les mois qui viennent après recensement des matériels récupérables de programmes antérieurs et évaluation complète des travaux à réaliser.

Descriptif du Systeme Arsene

Une étude préliminaire a montré que la masse du satellite sera de l'ordre d'une centaine de kilogrammes (comparable à la taille de certains satellites lancés par Diamant).

Son orbite finale sera obtenuc à l'aide d'un moteur auxiliaire à poudre à partir de l'orbite de transfert géostationnaire du passager principal d'Ariane.

La mission de télécommunications sera assurée par deux "transpondeurs" à accès multiple fonctionnant dans les bandes de fréquences attribuées aux radioamateurs par la récente Conférence Administrative Mondiale des Radiocommunications. Une balise sur fréquence très élevée servira de support de transmission à une petite expérience scientifique à définir.

La stabilisation sera assurée par couplage au champ magnétique terrestre et l'energie de bord fournie par des panneaux solaires (de récupération).

Le réseau au sol de télémesure et télécommande pourrait comprendre 3 stations (territoire métropolitain, Guyane française et sans doute la Réunion).

Toutes les stations de radio-amateurs pourront utiliser le dispositif de télécommunications pour des expérimentations et de nombreuses écoles techniques pourront se doter des équipements terriens simples pour procéder à des démonstrations ou des travaux pratiques.

La durée de vie d'un tel satellite pourrait être de quelques années.

Calendrier de L'operation

L'année 79 a été celle des contacts initiaux pour sensibiliser toutes les parties concernées et mettre en place l'organisation minimum nécessaire. Pendant le même temps, une étude préliminaire des masses et volumes disponibles dans plusieurs configurations de lancement a permis de dégager les ordres de grandeur du satellite passager auxiliaire et il a été vérifié que la mission type projetée (intervisibilité de plus d'une demi-heure entre un point situé au milieu des USA et un autre au milieu de l'Europe, plusieurs fois par jour) était compatible.

Les analyses de missions et la conception globale du système, en particulier celle du véhicule satellite, fera l'objet des travaux d'élèves de l'année scolaire 79-80.

Compte tenu des resultats acquis à l'automne 80, les études détaillés seront confiées aux promotions suivantes pour conduire soit fin 82 soit fin 83 aux dossiers de réalisation et d'essais. Il faut envisager deux ans de réalisation proprement dite. En fait le calendrier sera ajusté dès que sera arrêté le vol Ariane qui pourra se charger de ce satellite auxiliaire.

TRANSLATION:

Our thanks for the English translation of this material go to K9LF, VE2ASL and Dominique Hanley.

in months ahead after learning what available equipment and parts exist from prior space programs after making a complete analysis of the work required.

Description of the Arsene System

A preliminary study shows that the mass of the satellite will be in the order of 100 kilograms (comparable to the size of certain satellites put into orbit by the Diamant rocket).

Its final orbit will be attained with an auxiliary rocket motor using solid fuel moving the satellite from the geostationary transfer orbit of the principal satellite on the Ariane liftoff.

The telecommunication function of the satellite will have two transponders with multiple access and use frequencies given to amateurs under the recent WARC agreement. A very high frequency beacon will be used for a small scientific experiment yet to be defined. Stabilization of the satellite will be maintained by coupling with the earth's magnetic field. Energy for the satellite will be generated by rechargeable solar panels. The ground communication and control station functions could be maintained by three stations, one being the French Mainland, with the other two located in French Guiana and Reunion Island.

All Amateur Radio stations throughout the world will be able to use the transponders for experiments. Many technical schools could equip themselves with simple earth stations in order to make demonstrations and engage in practical experiments. The life expectancy for a satellite such as the one envisaged should be several years.

Operational Time Frame

1979 was for initial contacts to learn opinions of the different groups involved, and to put into place the minimum necessary organization. During this same period, a preliminary study of the masses and volumes available on various configurations of the available vehicles permitted the development of a conclusion concerning the order of magnitude for the satellite ''extra passenger.'' It has thus been verified that a mission such as the one projected (with visibility of approximately ½ hour between a point situated in the middle of the United States and another in the middle of Europe, several times each day) was compatible.

Analysis of available missions and the entire system which is envisaged, and in particular the satellite to be launched, will be studied by students during the school year 1979-1980. After seeing the results of the students who looked at this project in the fall of 1980, it is expected that the students will put together very complete documentation by the end of 1982 or perhaps the end of 1983. Thereafter, we should expect to take two years to build the satellite. Of course, the time line will be adjusted as soon as a particular launch opportunity on the Ariane can be identified.

ORBITAL PREDICTIONS

By Project OSCAR, Inc.

AO-7 Period (min/orbit) =
$114.9470775 - 1.805 \times 10^{-7} \times$ orbit number
Ang. Inc. (deg./orbit) = 28.73725°

AO-8 Period (min/orbit) =
$103.2330 - 2.35 \times 10^{-6} \times$ orbit number
Ang. Inc. (deg./orbit) =
$25.810834 - 6.5 \times 10^{-7} \times$ orbit number

For complete details concerning the development of these monthly predictions, please read the discussion by John Pronko, W6XN, given in November/December 1980 Orbit *Magazine on page 25.*

Note AMSAT-OSCAR 7 Schedule is as follows: Mode A, Monday, Thursday and Saturday; Mode B, Sunday, Tuesday, Wednesday (x) and Friday.

U.T.C. DATE	-- AMSAT-OSCAR 7 --			-- AMSAT-OSCAR 8 --			
	TIME (HMM:SS)	DEG.	ORBIT NUMBER	TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
THU. 1 JAN. (1)	132:11	98.5	28042	103:02	72.6	14402	A
FRI. 2 JAN. (2)	31:30	83.3	28054	107:49	73.8	14416	A+J
SAT. 3 JAN. (3)	125:44	96.9	28067	112:37	75.0	14430	J
SUN. 4 JAN. (4)	25:03	81.8	28079	117:24	76.2	14444	J
MON. 5 JAN. (5)	119:17	95.3	28092	122:11	77.5	14458	A
TUE. 6 JAN. (6)	18:36	80.2	28104	126:58	78.7	14472	A+J
WED. 7 JAN. (7)	112:50	93.8	28117	131:45	79.9	14486	X
THU. 8 JAN. (8)	12:09	78.6	28129	136:33	81.1	14500	A
FRI. 9 JAN. (9)	106:23	92.2	28142	141:20	82.3	14514	A+J
SAT. 10 JAN. (10)	5:42	77.0	28154	2:55	57.8	14527	J
SUN. 11 JAN. (11)	59:56	90.6	28167	7:42	59.0	14541	J
MON. 12 JAN. (12)	154:11	104.2	28180	12:29	60.2	14555	A
TUE. 13 JAN. (13)	53:29	89.1	28192	17:16	61.4	14569	A+J
WED. 14 JAN. (14)	147:44	102.6	28205	22:03	62.6	14583	X
THU. 15 JAN. (15)	47:02	87.5	28217	26:50	63.9	14597	A
FRI. 16 JAN. (16)	141:17	101.1	28230	31:37	65.1	14611	A+J
SAT. 17 JAN. (17)	40:35	85.9	28242	36:24	66.3	14625	J
SUN. 18 JAN. (18)	134:50	99.5	28255	41:10	67.5	14639	J
MON. 19 JAN. (19)	34:08	84.4	28267	45:57	68.7	14653	A
TUE. 20 JAN. (20)	128:23	97.9	28280	50:44	69.9	14667	A+J
WED. 21 JAN. (21)	27:41	82.8	28292	55:31	71.2	14681	X
THU. 22 JAN. (22)	121:56	96.4	28305	100:18	72.4	14695	A
FRI. 23 JAN. (23)	21:14	81.2	28317	105:04	73.6	14709	A+J
SAT. 24 JAN. (24)	115:29	94.8	28330	109:51	74.8	14723	J
SUN. 25 JAN. (25)	14:47	79.6	28342	114:38	76.0	14737	J
MON. 26 JAN. (26)	109:02	93.2	28355	119:24	77.3	14751	A
TUE. 27 JAN. (27)	8:20	78.1	28367	124:11	78.5	14765	A+J
WED. 28 JAN. (28)	102:35	91.7	28380	128:57	79.7	14779	X
THU. 29 JAN. (29)	1:53	76.5	28392	133:44	80.9	14793	A
FRI. 30 JAN. (30)	56:08	90.1	28405	138:30	82.1	14807	A+J
SAT. 31 JAN. (31)	150:23	103.7	28418	0:05	57.5	14820	J

U.T.C. DATE	-- AMSAT-OSCAR 7 --			-- AMSAT-OSCAR 8 --			
	TIME (HMM:SS)	DEG.	ORBIT NUMBER	TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
SUN. 1 FEB. (32)	49:41	88.5	28430	4:52	58.8	14834	J
MON. 2 FEB. (33)	143:55	102.1	28443	9:38	60.0	14848	A
TUE. 3 FEB. (34)	43:13	87.0	28455	14:24	61.2	14862	A+J
WED. 4 FEB. (35)	137:28	100.5	28468	19:11	62.4	14876	X
THU. 5 FEB. (36)	36:47	85.4	28480	23:57	63.6	14890	A
FRI. 6 FEB. (37)	131:01	99.0	28493	28:43	64.8	14904	A+J
SAT. 7 FEB. (38)	30:19	83.8	28505	33:30	66.1	14918	J
SUN. 8 FEB. (39)	124:34	97.4	28518	38:16	67.3	14932	J
MON. 9 FEB. (40)	23:52	82.3	28530	43:02	68.5	14946	A
TUE. 10 FEB. (41)	118:07	95.8	28543	47:49	69.7	14960	A+J
WED. 11 FEB. (42)	17:25	80.7	28555	52:35	70.9	14974	X
THU. 12 FEB. (43)	111:40	94.3	28568	57:21	72.1	14988	A
FRI. 13 FEB. (44)	10:58	79.1	28580	102:07	73.3	15002	A+J
SAT. 14 FEB. (45)	105:13	92.7	28593	106:53	74.6	15016	J
SUN. 15 FEB. (46)	4:31	77.5	28605	111:39	75.8	15030	J
MON. 16 FEB. (47)	58:46	91.1	28618	116:25	77.0	15044	A
TUE. 17 FEB. (48)	153:00	104.7	28631	121:11	78.2	15058	A+J
WED. 18 FEB. (49)	52:18	89.6	28643	125:57	79.4	15072	X
THU. 19 FEB. (50)	146:33	103.1	28656	130:43	80.6	15086	A
FRI. 20 FEB. (51)	45:51	88.0	28668	135:29	81.8	15100	A+J
SAT. 21 FEB. (52)	140:06	101.6	28681	140:15	83.1	15114	J
SUN. 22 FEB. (53)	39:24	86.4	28693	1:49	58.5	15127	J
MON. 23 FEB. (54)	133:39	100.0	28706	6:35	59.7	15141	A
TUE. 24 FEB. (55)	32:57	84.9	28718	11:21	60.9	15155	A+J
WED. 25 FEB. (56)	127:12	98.4	28731	16:07	62.1	15169	X
THU. 26 FEB. (57)	26:30	83.3	28743	20:52	63.3	15183	A
FRI. 27 FEB. (58)	120:45	96.9	28756	25:38	64.5	15197	A+J
SAT. 28 FEB. (59)	20:03	81.7	28768	30:24	65.8	15211	J

U.T.C. DATE	-- AMSAT-OSCAR 7 --			-- AMSAT-OSCAR 8 --			
	TIME (HMM:SS)	DEG.	ORBIT NUMBER	TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
SUN. 1 MAR. (60)	114:17	95.3	28781	35:10	67.0	15225	J
MON. 2 MAR. (61)	13:36	80.1	28793	39:55	68.2	15239	A
TUE. 3 MAR. (62)	107:50	93.7	28806	44:41	69.4	15253	A+J
WED. 4 MAR. (63)	7:08	78.6	28818	49:27	70.6	15267	X
THU. 5 MAR. (64)	101:23	92.2	28831	54:12	71.8	15281	A
FRI. 6 MAR. (65)	0:41	77.0	28843	58:58	73.0	15295	A+J
SAT. 7 MAR. (66)	54:56	90.6	28856	103:43	74.2	15309	J
SUN. 8 MAR. (67)	149:10	104.2	28869	108:29	75.5	15323	J
MON. 9 MAR. (68)	48:29	89.0	28881	113:14	76.7	15337	A
TUE. 10 MAR. (69)	142:43	102.6	28894	118:00	77.9	15351	A+J
WED. 11 MAR. (70)	42:01	87.5	28906	122:45	79.1	15365	X
THU. 12 MAR. (71)	136:16	101.0	28919	127:30	80.3	15379	A
FRI. 13 MAR. (72)	35:34	85.9	28931	132:16	81.5	15393	A+J
SAT. 14 MAR. (73)	129:49	99.5	28944	137:01	82.7	15407	J
SUN. 15 MAR. (74)	29:07	84.3	28956	141:46	83.9	15421	J
MON. 16 MAR. (75)	123:22	97.9	28969	3:20	59.4	15434	A
TUE. 17 MAR. (76)	22:40	82.8	28981	8:05	60.6	15448	A+J
WED. 18 MAR. (77)	116:54	96.3	28994	12:50	61.8	15462	X
THU. 19 MAR. (78)	16:12	81.2	29006	17:36	63.0	15476	A
FRI. 20 MAR. (79)	110:27	94.8	29019	22:21	64.2	15490	A+J
SAT. 21 MAR. (80)	9:45	79.6	29031	27:06	65.4	15504	J
SUN. 22 MAR. (81)	104:00	93.2	29044	31:51	66.6	15518	J
MON. 23 MAR. (82)	3:18	78.0	29056	36:36	67.8	15532	A
TUE. 24 MAR. (83)	57:33	91.6	29069	41:21	69.0	15546	A+J
WED. 25 MAR. (84)	151:47	105.2	29082	46:06	70.2	15560	X
THU. 26 MAR. (85)	51:05	90.1	29094	50:51	71.5	15574	A
FRI. 27 MAR. (86)	145:20	103.6	29107	55:36	72.7	15588	A+J
SAT. 28 MAR. (87)	44:38	88.5	29119	100:21	73.9	15602	J
SUN. 29 MAR. (88)	138:53	102.1	29132	105:06	75.1	15616	J
MON. 30 MAR. (89)	38:11	86.9	29144	109:51	76.3	15630	A
TUE. 31 MAR. (90)	132:26	100.5	29157	114:36	77.5	15644	A+J

U.T.C. DATE	-- AMSAT-OSCAR 7 --			-- AMSAT-OSCAR 8 --			
	TIME (HMM:SS)	DEG.	ORBIT NUMBER	TIME (HMM:SS)	DEG.	ORBIT NUMBER	SCHED. MODE
WED. 1 APR. (91)	31:44	85.4	29169	119:21	78.7	15658	X
THU. 2 APR. (92)	125:58	98.9	29182	124:05	79.9	15672	A
FRI. 3 APR. (93)	25:16	83.8	29194	128:50	81.1	15686	A+J
SAT. 4 APR. (94)	119:31	97.4	29207	133:35	82.3	15700	J
SUN. 5 APR. (95)	18:49	82.2	29219	138:20	83.6	15714	J
MON. 6 APR. (96)	113:04	95.8	29232	143:05	84.8	15728	A
TUE. 7 APR. (97)	12:22	80.6	29244	4:37	60.2	15741	A+J
WED. 8 APR. (98)	106:36	94.2	29257	9:22	61.4	15755	X
THU. 9 APR. (99)	5:54	79.1	29269	14:07	62.6	15769	A
FRI. 10 APR. (100)	100:09	92.7	29282	18:51	63.8	15783	A+J
SAT. 11 APR. (101)	154:24	106.2	29295	23:36	65.0	15797	J
SUN. 12 APR. (102)	53:42	91.1	29307	28:20	66.2	15811	J
MON. 13 APR. (103)	147:56	104.7	29320	33:05	67.4	15825	A
TUE. 14 APR. (104)	47:14	89.5	29332	37:49	68.6	15839	A+J
WED. 15 APR. (105)	141:29	103.1	29345	42:34	69.8	15853	X
THU. 16 APR. (106)	40:47	88.0	29357	47:18	71.0	15867	A
FRI. 17 APR. (107)	135:02	101.5	29370	52:03	72.2	15881	A+J
SAT. 18 APR. (108)	34:20	86.4	29382	56:47	73.5	15895	J
SUN. 19 APR. (109)	128:34	100.0	29395	101:31	74.7	15909	J
MON. 20 APR. (110)	27:52	84.8	29407	106:16	75.9	15923	A
TUE. 21 APR. (111)	122:07	98.4	29420	111:00	77.1	15937	A+J
WED. 22 APR. (112)	21:25	83.3	29432	115:44	78.3	15951	X
THU. 23 APR. (113)	115:40	96.8	29445	120:28	79.5	15965	A
FRI. 24 APR. (114)	14:58	81.7	29457	125:13	80.7	15979	A+J
SAT. 25 APR. (115)	109:12	95.3	29470	129:57	81.9	15993	J
SUN. 26 APR. (116)	8:30	80.1	29482	134:41	83.1	16007	J
MON. 27 APR. (117)	102:45	93.7	29495	139:25	84.3	16021	A
TUE. 28 APR. (118)	2:03	78.5	29507	0:57	59.7	16034	A+J
WED. 29 APR. (119)	56:17	92.1	29520	5:42	60.9	16048	X
THU. 30 APR. (120)	150:32	105.7	29533	10:26	62.1	16062	A

The AMSAT-GOLEM 80 Project

Part I of this article appeared in the September 1979 issue of Byte.[1] It described the basic concept of a low cost S-100 based microcomputer designed for group construction projects that could be put together around almost any manufacturer's set S-100 cards. The AMS-80 PROM monitor/debug package was also outlined. I/O connector interfaces were given to allow equipment built for one system to operate in another system environment.

By Joe Kasser, G3ZCZ*

The Hardware

The standard system comprises the CPU, RAM, PROM and I/O to drive a terminal. The AMSAT "hardcore" are also using Northstar floppy disc controller cards in their systems. Several S-100 cards have been developed for the AMSAT telemetry tracking and command station network, as well as for use in the general amateur radio station.

A *front panel card* set was also developed for the home constructor. It consists of two cards: an interface and a binary switch/display card. The two cards are interconnected by means of two 40-pin ribbon cables. They are physically constructed so that the two cards can be bolted together using spacers. The circuitry of the cards contain a DMA front panel that puts the CPU into a "hold" state and allows the operator to read and modify an I/O port and memory locations. The address bus is controlled by an up/down counter allowing the operator to examine the memory sequentially counting up or down. A single step facility is also available for program debugging. An I/O port at address 0FF HEX is also present to allow the computer to communicate with the operator during the execution of programs.

These cards can thus be used in the following manner:

a) As a permanent front panel built into a home brew system by mounting the switch/display card remotely from the interface card.
b) As a portable test set for bringing up a system for the first time or troubleshooting a front panelless system that has developed hardware problems.

The switch/display card has separate LED's and switches for the address and data bus's and provides LED's that monitor the status of the control bus. A reset and interrupt switch are provided. The interrupt switch can be jumpered to provide any one of the eight levels and is usually set to provide an AMS-80 breakpoint function in the AMSAT-GOLEM-80 system.

The *station controller card* contains a hardware time-of-day clock, six reed relays and a multiplexed seven-channel analog-to-digital converter. This card is designed for control applications such as azimuth/elevation control of OSCAR tracking and communication antennas, transmitters and receivers. The relays perform the control functions and analog voltages such as antenna position or receiver agc level and are fed back to the analog-to-digital converter for input to the processor as digital signals. A description of the interface control software (written in BASIC and IPS) was published in the November/December 1980 issue of *ORBIT* Magazine.[2]

The *Telemetry-Range (TRUMP) card* provides a number of features. It contains an audio tone generator that can be used to provide a "bell" tone, or it may be used as a cw monitor. It contains a counter-timer device that can be used as a baud rate generator for the on-card USART, as well as providing real time interrupts for the IPS environment. The USART can be used in the ASCII or Baudot mode, the serial output being at TTL levels. It also has the facility for several modulation/demodulation schemes apart from the standard NRZ format. This feature was designed to provide the interface between the microcomputer and the AMSAT-Phase III 400-Baud synchronous telemetry data.

The *Radio Teletypewriter Interface card (AR-1)* is designed as an RTTY peripheral for the S-100 computer. It contains a USART allowing both Baudot and

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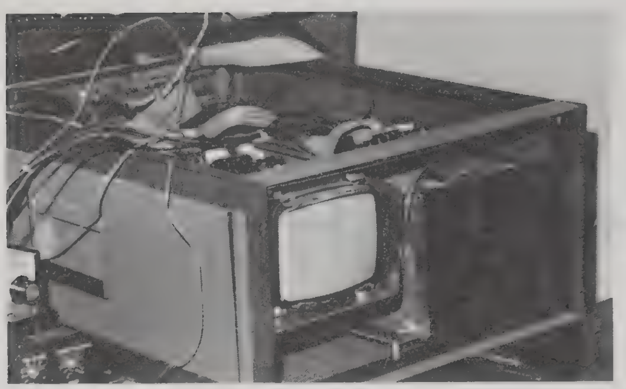
*Editor, *Orbit* Magazine.



G3ZCZ's Mark II version contains 16 slot motherboard, two floppy disk drives and a five-inch monitor. This photograph was taken before the front panel was installed.

ASCII to be used under software control. A crystal-controlled baud rate generator allows the serial port to work at 45.5, 50, 56, 75 and 110 Bauds. Serial I/O may be taken off the card at RS-232 levels, thus allowing the use of Model 15 or 28 teleprinters as console or list devices (using the conversion software in AMS-80). Alternatively the RS-232 I/O signals may be jumped across to the analog section of the card which comprises a modified ST-5 Terminal Unit and AK-2 AFSK generator. Thus the card may be used as a complete RTTY station or as an I/O card for a Baudot 45.5 Baud printer.

The Software

The basic level of software is AMS-80. It was described in Part 1 and contains the main system I/O drivers and an extensive monitor or debug package. Once the basic system has been built it tends to become a floppy-disc based system and uses a Disc Operating System (DOS). The standard AMSAT-GOLEM-80 machines use Northstar DOS customized for AMS-80 I/O drivers, which just happen to be compatible to the TDL/Xitan Zapple monitor. A floppy disc system is an expensive acquisition. To provide for an intermediate mode in which software is loaded from tape or contained in PROM, a PROM Based Operating Systems (PROMOS) was developed. It allows programs to be saved/exchanged in PROMS and executed by typing in the program name; PROMOS is intended for use with an intermediate level system that does not include a floppy disc subsystem.

A few programs have been written in BASIC, or 8080 assembly language, but the vast majority of the Phase III related software is in IPS.[3] IPS is an indirect threaded code language similar to FORTH developed by Dr. Karl Meinzer, DJ4ZC. It is not available outside the *hardcore* at this time. However, since it is so close to FORTH in its grammatical structure, any FORTH system can be made to execute code written in IPS. The unique aspect of IPS is the multitasking capability. It can perform up to seven simultaneous user defined tasks that can each be scheduled for execution at any time or time intervals based on a 20 millisecond interrupt (provided by the TRUMP card).

Availability

The AMSAT version of IPS (Rev 3.4.1) was developed by Ron Dunbar, W0PN, for use with the Phase III telemetry tracking and command stations; thus, the current version is highly Phase III oriented. W0PN is now rewriting the kernel to make it CP/M compatible. This version, to be released as Rev 5.0 in the fourth quarter of 1981, will be available to all AMSAT members. An announcement to that effect will appear in the pages of *ORBIT*. Rev 5.0 will allow any S-100 microcomputer containing a TRUMP card (or equivalent 20-ms interrupt generator circuitry) a memory mapped video display and a CP/M operating system to run IPS. In the meantime we recommend that you examine STOIC (CP/M user group volume 23), study FORTH[4] and wait for an announcement regarding the availability of IPS.

The hardware is available as bareboards, kits or assembled and tested and comes with sample software as applicable. AMS-80 documentation, including the source code, is available as is the source code in CP/M (eight inch or Northstar), ISIS or Tekronix MDS compatable floppy discs. For further information write to Snow Micro Systems, Inc., P.O. Box 1704, Silver Spring, Maryland 20902.

Acknowledgements

The author would like to acknowledge the efforts of W3IWI, W1HDX, W0PN, KB3KX, W6PAJ, VE1SAT and numerous others in the development of the hardware and software associated with the project.

References

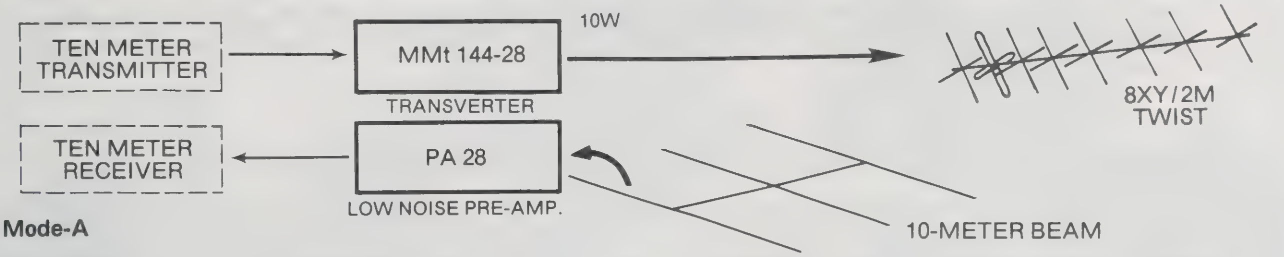
1. An outline was also published in the September 1977 issue of the *AMSAT Newsletter*.

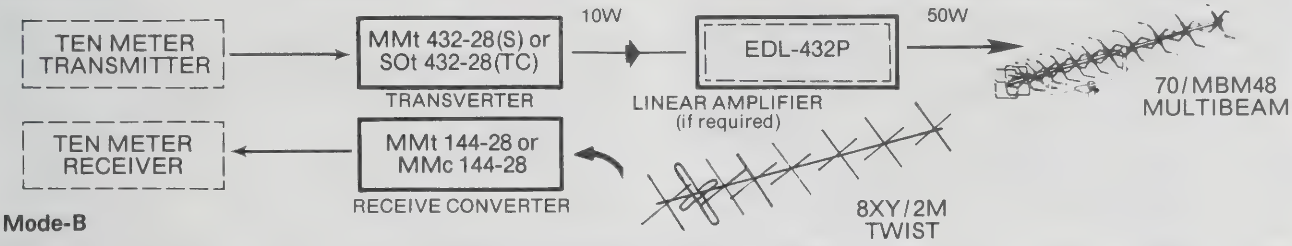
2. Reymann, S., "Pointing Your Antenna By Computer," *ORBIT* Magazine, Nov./Dec. 1980.

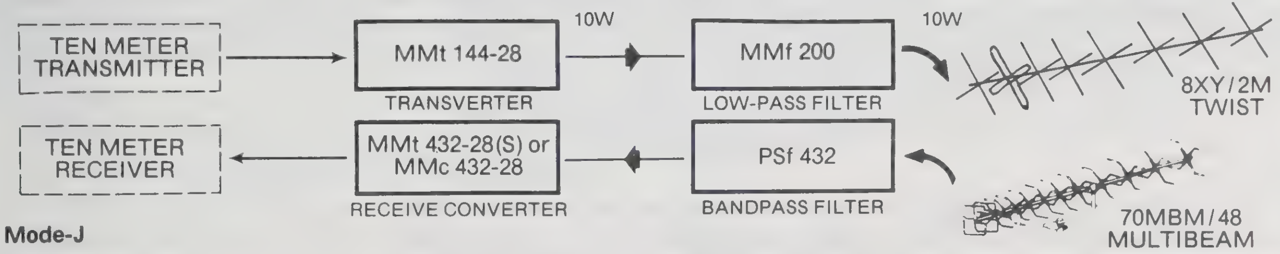
3. Karl Meinzer, "IPS, An Unorthodox High Level Language," *Byte Magazine*, January 1979.

4. For an intensive discussion on all aspects of FORTH, see the August and September 1980 issues of *Byte Magazine*.

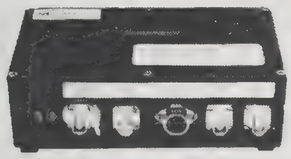
OSCAR SYSTEMS FROM SPECTRUM INTERNATIONAL







CONVERTERS AND TRANSVERTERS FOR



OSCAR 7
OSCAR 8
PHASE III

Specifications:

Output Power: 10W.
Receiver N.F.: 3 dB typ.
Receiver Gain: 30 dB typ.
Prime Power: 12 Vdc

Receive Converters:

MMc 144	$59.95
MMc 432-28(s)	$89.95
MMc 432-28(TC)	$84.95

UHF Filters:

MMf 200-5	$31.95
MMf 200-7	$42.95
PSf 432	$59.95

Receive Preamplifier:

PA-28	$35.95

Mod. kit to adapt original MMt 432-28 FOR Mode-J operation: $26.50

Transverters by Microwave Modules and other manufacturers can convert your existing low-band rig to operate on the VHF and UHF bands. Models also available for 2M to 70 Cm and for ATV operators from Ch2/Ch3 to 70 Cm. Each transverter contains both a Tx up-converter and an Rx down-converter. Write for details of the largest selection available.

Attention owners of the original MMt 432-28 models: Update your transverter to operate OSCAR 8 and Phase III by adding the 434 to 436 MHz range. Mod. kit including full instructions is $26.50 plus $1.50 shipping.

ANTENNAS

2-Meter 8 + 8 Twist Model 8XY/2M	$57.75
Phasing Harness Model PMH/2C	$12.35
48 el. 70 Cm Multibeam Model 70-MBM-48	$69.95
88 el. 70 Cm Multibeam Model 70-MBM-88	$95.95

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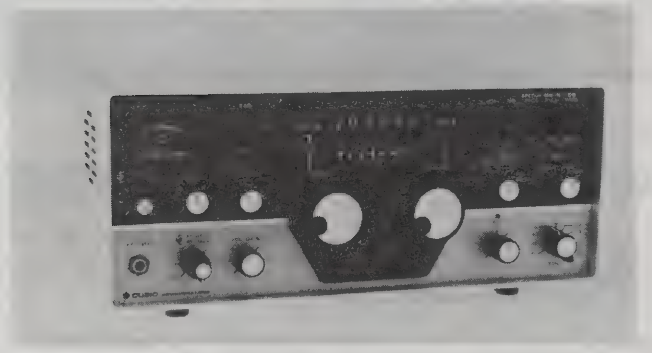

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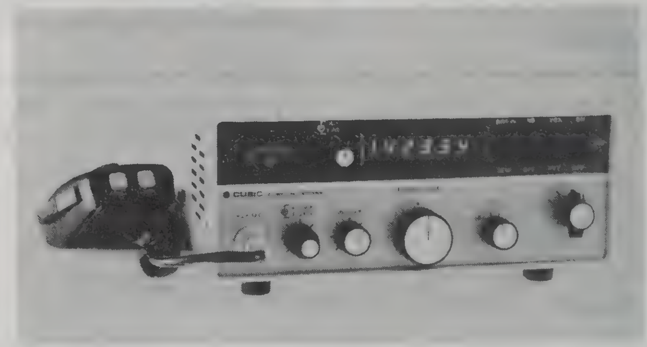

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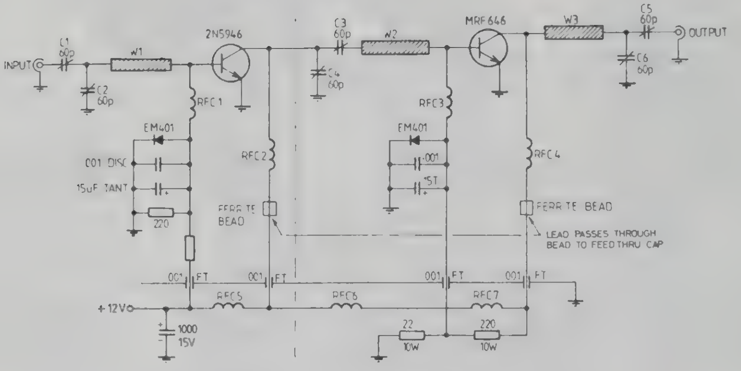
Around the World

By Kaz J. Deskur, K2ZRO*

Articles about the Radio Amateur Satellite Program are being published around the world. Some of this material, which appeared in languages other than English, was never translated and thus did not reach the maximum number of interested readers. *ORBIT* provides abstracts of such articles as they appear, and provide an indication of the level of publishing activity worldwide in the field of Amateur Space activities.



Novel Elliptically Polarized Crossed-Dipoles

An interesting version of circularly (almost) polarized crossed dipoles not requiring the phasing section was described by K. Khachenko in the July 1979 issue of the Russian magazine *Radio*. Not being able to obtain the original article I can only summarize two abstracts that appeared in recent issues of *Amateur Radio* (Australia) and *Radio Communication* (RSGB) and draw my own conclusions from the published impedance diagram.

The antenna resembles a conventional crossed-dipole but there is a difference: the two dipoles are not of equal length; one of the sections is longer and the other shorter than a *correct* dipole cut to the working frequency. The antenna is fed directly by a 75 ohm transmission line, Fig. 1 (a). Judging from the vector diagram, Fig. 1 (c), it is evident that the length of the dipoles is adjusted so the reactive component of each dipole equals 75 ohms (inductive for the longer and capactive for the shorter element); and, at the same time, the phase difference between the currents in each dipole is arranged to be 90°. Apparently, the given lengths of the dipoles, 0.54 wavelength and 0.46 wavelength respectively, fulfill those conditions. Because there is a 90° phase shift between the currents in each section, the antenna should be circularly polarized. Examination of the impedance plot will reveal however, that the currents in both dipoles will not be exactly equal; consequently the true circular polarization can not be realized. Calculations indicate that the difference between the horizontal and the vertical components will amount to only about 15 percent, which is insignificant. The computed theoretical impedance of the equivalent circuit Fig. 1 (b) appears to be resistive and very close to the 75 ohm value.

Without a doubt this simple antenna will work well for reception of the 10-meter satellite down-link because the circularly (or even elliptically) polarized antenna reduces fading of signals caused by the Faraday rotation and changes of the orientation of the spacecraft in reference to the ground station.

Helical Antenna Calculations

The September 1980 issue of *Microwaves* (an industrial trade magazine) contains an interesting paper by Klaus Breitkopf. The author presents an algorithm for the HP-97 scientific calculator that allows for plotting the field strength of helical antennas of different configurations (number of turns, pitch angle, etc.). All pertaining equations are provided; therefore, it is conceivable that similar programs can be developed employing other computer languages.

432-MHz Power Amplifier

In the April issue of *Amateur Radio* (Australia) Ian Glenville, VK3AQU, describes modification of the 432-MHz amplifier first published in July 1977 *QST* and developed by K2OVS. The original design specifies type MRF 5176 and MRF 306 transistors requiring a 28-volt supply. VK3AQU's version uses the same pc board and employs type 2N5946 and MRF 646 transistors which are less expensive and can be operated from the more conventional 12-volt supply. The claimed output is in excess of 40-watts PEP. Because the adjustment of the amplifier is rather involved and somewhat hazardous (to the transistors), those who intend to duplicate this circuit should become familiar with the original article.

Phase II Tracking Program

A program for tracking circularly orbiting satellites, and provides az-el data for the user's QTH, is described in the December 1980 issue of *CQ Magazine*. The program is written for a Radio Shack TRS 80 Level II computer. The author, K8BG (Buzz Gonsky, 712 Hillside Drive, Carlisle, PA 17013) will copy and verify the program for those that send him a blank tape and a SASE with sufficient postage, for its return.

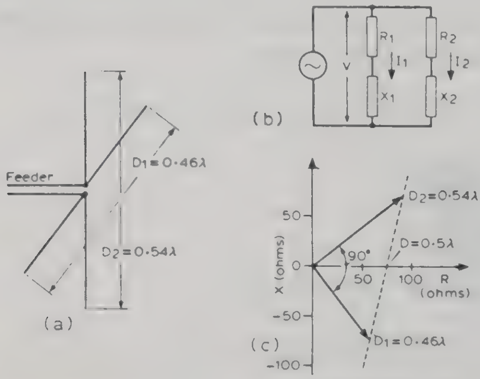


Fig. 1 — (a) Russian technique providing simple elliptically-polarized crossed-dipole antenna element which dispenses with phasing stub; (b) equivalent circuit of dipole feed points; crossed dipole impedance plot.

*Box 11, Endicott, NY 13760

Letters

QST & Satellite DXCC

Having not seen the June 1980 *QST*, I first learned of the limitation placed upon the Satellite DXCC from K4UAS's letter to *ORBIT*, Sept./Oct. 1980, and feel a large amount of sympathy with his viewpoint. On the other hand, I can well appreciate the point of view of the ARRL DXAC, as there will be little merit in a DXCC obtained by the use of Phase III when the DX supply will be limited only by the difficulties imposed upon the rarer developing countries by money supply, technical requirement, and power limitations. Yet numerous parts of the world would find it quite impossible to achieve the award with polar sun-synchronous satellites of less than 1500 miles altitude!

Those on the verge of DXCC/s should not lose hope, but refer to page 18 of the June/-July 1980 *ORBIT*. Three Soviet satellites are on the way, the next one being imminent, and many people managed to finalize their DXCC's and WAS Satellite by the use of RS-1 and 2 until the irresponsible power levels of some over-enthusiastic competitive operators rendered them useless. It is perhaps this last point that is the main reason that ARRL has decided not to award the certificate for Phase III contacts, *viz.* the fact that one indiscriminate user can effectively wipe out all the opposition merely by totally attenuating all logically powered uplinks by the use of excessive power that over activates the ALC control system.

Really, merit is better rewarded on satellites than by Tropo, F2, Aurora, or any other "natural" propogation-dependent mode, as the degree of achievement with satellites is almost totally dependent upon the calculation, tracking and skill of the user, as distinct with other phenomena which are often erratic, non-predictable and mainly a matter of good fortune rather than planning.

If future satellites are equipped with a means of selective attenuation eliminating the advantage of the excessive use of power, or even shut-off so that no one, including the offender, can use them until sensible operation is effected, I see no reason as to why the use of satellites of any coverage should exclude any operating award.—*G3IOR*

For further information see page 30—*Editor*

ORBIT

I cannot express in words how pleased I am with AMSAT's revised format of its newsletter. The logo and title is very appropriate and has all of the finishing touches of being professional. Under the editorship of Joe Kasser, G3ZCZ, I'm sure all of us will see and read great articles in *ORBIT*.

However, like most people, I have a gripe: I feel left out from the AMSAT world since the net is on 3850. Am I to understand that Advanced people are more capable of understanding AMSAT activities than the General people? Or do the Generals have 'no need to know?'—*W9SON*

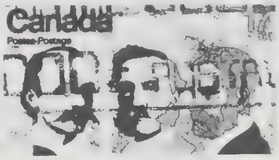
See 40m net, Sunday's 0800 Eastern Time on 7280 MHz—*Editor*

This is just to let you know that you did an excellent job on Vol. 1, No. 1. I think that issue will become the satellite eras equivalent to December 1915 *QST*. Great work!—*KA4LRT*

It's still available from the Back Issue department, for those who missed it, at $3.00 postage paid.—*Editor*

I enjoy *ORBIT* very much and look forward to each issue. Someday *ORBIT* will be the most popular magazine in amateur radio.—*WD0HHU*

Congratulations on our new magazine ORBIT. I have received numbers 2 and 3 so far and find it to be an excellent publication, a far cry from our old *AMSAT Newsletter*. May it grow and mature, to be worthy of being called an AMSAT publication. Keep up the good work.—*ZL1ASQ*



China

On Aug. 22-24, a JARL Hamfestival '80 was held in Tokyo. A delegation of the Radio Sports Assoc. of China was there and visited the JAMSAT booth. I explained to them about the history of Amateur Radio Satellites, AMSAT-OSCAR 8, and our plans for Phase III.

They were very interested in the Amateur Radio Satellites. I gave them copies of JAMSAT's AMSAT-OSCAR 8 users' guide book and an *AMSAT Newsletter*. There are now prohibitions against Amateur Radio in the Peoples' Republic of China, but I think that Amateur Radio will appear there in the near future.—*JR1ETY*

Russian Satellites

I believe the article on Russian Satellites, Vol. 1, No. 3 (Sept./Oct. 1980) page 9 could be improved a bit on the binary code.

For the letters P to H, remove the least significant digit zero. Then invert the sequence of digits. Using the weighting scheme of 1, 2, and 4 will then give the required binary number converted to decimal form. For example: P = 0110 = 011 = 110 = 1 x 4 + 1 x 2 + 0 x 1 = 4 + 2 + 0 = 6. For the letters O to S, invert the sequence and then apply the weighting scheme.

The figures on pages 11 and 13 have some very small type. I suggest that all figures have a minimum size type which is legible without a magnifying glass—*Bob Ashworth*

"Simple" Works

I wish more encouragement could be made for simple low-power operation. For seven years I didn't even bother trying to operate from my apartment. I now own a house. My station is ½-watt out on 146 MHz through 40 feet of RG-58 to a ¼-wavelength ground plane in the attic. On overhead passes I'm 6-10 dB out of the noise. With the amplifier (30 watt) I can access AMSAT-OSCAR 7 and 8 once they're 30° above the horizon. Nothing exotic but it has certainly reignited my interest in Amateur Radio.—*WA8LLY*

Details, Details, Details

I very much like the way *ORBIT* is developing. No. 2 was excellent. The visual impact of the magazine is very good, and I particularly enjoyed G3IOR's feature. I realize *ORBIT* cannot cater to one individuals tastes, but there are several fields where I would like to get information.

(a) Regular list of satellite launches, basic orbit details, mission information, downlink frequencies and data formats.

(b) More specific details of downlinks and data formats for interesting 'birds' such as the Space Telescope. (I would like to be able to look in when it is operating.)

(c) Downlinks for deeper space missions. I presently use SRET 2 at 45,000 km for my checks but would like to try ISEE C out at L1 Sun Earth libration point 1.5 million kms. Can anyone provide this data for a short *ORBIT* column?—*GM4IHJ*

We are trying—*Editor*

Ballots

I feel it important to state how impressed I was with the candidates listed on my ballot for Board of Directors. I found it a refreshing change to have such a well qualified group of candidates, and I'm sure that no matter which of them 'win'—the real winners will be all of us, and AMSAT will be in good hands.—*WB9FRV*

Mailed my ballot envelope a few days ago, but please note it was returned to *my* address on two occasions. Reasons? Well, the United Kingdom postal services insist that *red* ink *must not* be used on the envelope address panel and the *senders name must not be* on the *front* of the envelope but *should* appear on the *rear* of the envelope. Don't know the situation with other European countries!—*G3OCG*

Ah So!—the USPS is not unique—*Editor*

E.M.E. NEWS

By Al Katz, K2UYH*

Conditions were again excellent during the October EME Weekend, but not quite as good as last time. The big news this month is the SK2GJ 1296 tests and the surprise appearance of the big Arecibo dish on 432 MHz.

SK2GJ Tests: The SK2GJ operation was somewhat disappointing. They were plagued by moon tracking problems and did not make it on at all the first day. Finally they got things squared away around 0300 on the 26th and worked five or six stations (all well equipped). They had only 40 watts from a single 2C39, but were heard by two ZL's using only 6 foot dishes and possibly even one station using loop yagis. The tests seem to have already generated a significant serge of interest in 1296 EME.

Arecibo on 432: Some "spare" time became available on the 1000 foot dish at Arecibo, Puerto Rico on Wednesday October 29 between 1000 and 1045, WA3FET/KP4, KP4EKA, NP4R and NP4B were able to gain permission from the lab director to use the big dish on 432 EME. W1JR, W7GBI and W6ABN were notified by telephone of the tests and a telephone chain was set up to let as many others as possible know of the tests. The Arecibo dish has 60.4 dBi of gain on 432. This was enough to turn the 44 watts PEP of ssb available into a real EME rock crusher. A parametric amplifier was used for receive. In 40 minutes of bedlam, more than 25 QSO's on cw and ssb were made with W1JR, W0RRY, K5JL, WB5LUA, VE7BBG, W5UKQ, K4QIF, W6ABN, W7GBI, VE4MA, W0RAP, W7JF, W1XP and W1UHE. When the dish will again be available for amateur use is unknown. QSL cards may be sent to Robert Zimmerman, NP4B, Observatorio de Arecibo, P.O. Box 995, Arecibo, Puerto Rico 00612.

SM0DFP: SM0FFS, SM5BFK and SM0DFP have joined forces to put another amateur station on 1296 EME. Their system consists of an 8 meter dish with circular feed, OZ9CR ring amp and NE645 preamp (12 dB of sun noise). On October 26 they made their first QSO at 0530 with PA0SSB (349/349) followed at 0615 by W6YFK (0/0). Also heard were G3WDG and SK2GJ. Their moon window is blocked toward Asia but they are interested in skeds with European and North American stations.

VE7BBG: Cor decided to concentrate all his efforts on 1296 MHz during the skeds weekend because of the SK2GJ tests. On the 26th he worked on 1296 MHz at 0528 G3WDG (439/439), 0613 SK2GJ (43/43) on ssb, 0641 PA0SSB (539/539) and Q3 on ssb and 0712 G3LTF (0/0). Also heard were DJ4AU and W6YFK. Jan told Cor that he had worked SM0DFP. Cor was among the multitude who participated in the 432 Arecibo test on October 29. He worked KP4EKA on cw and ssb. Cor has been experimenting with the new MGF-1200 device which sells for around $15 dollars. His one produced a .65 dB NF and 12 dB of gain on 1296.

G3WDG: Charlie reports one of the best EME weekends so far! On the 24/25th G3WDG worked at 2140 OK3CTP (0/0), DL7YCA (449/349), 0030 DL7QY (M/M) initial #60, 0115 ZE5JJ (0/0) and 0425 DL9KR (559/459). Nil was heard in skeds with DL6WU and JE6CTS. M's were exchanged with both W1UHE and XE1RY, but no R's were heard. YF Petra, G4KGC using only 100 watts ran tests with ZE5JJ (only T) and DL9KR (M/M) QSO. Julian, G3YGF worked SM2GGF, DL7YCA, ZE5JJ and W7GBI (0/0). On 1296, on the 25th they worked at 2024 VK5MC (0/M), 2100 PA0SSB (449/349) and (4/3 on ssb), 2218 G3LTF (0/0), 0230 DJ4RU (0/0), 0300 K4QIF nil, 0335 SK2DJ (0/559), 0400 W6YFK (439/419)

VE4MA system consisting of eight 19-element Yagis.

---

*Dept. of Eng. Tech., Trenton State College, Trenton. NJ 08625

JA9BOH

for initial #9 and 0518 VE7BBG (439/439). Charlie is now getting .55 dB NF from a new GAT6 preamp using a copper input line rather than a brass one. He is still having troubles with thermal stability of his UPX-4 ring amp. (Does anyone have any ideas?)

F9FT: The big news from France is Franck's marriage to Liuda in UP-land this past September. Liuda is still in the USSR and Franck is thus doing a lot of traveling which is limiting his EME activity. He expects to have Liuda in Reims by the spring. Franck also reports that the ban on French 1296 MHz operation may be lifted shortly. In anticipation he has build up an array of 16 F9FT 1296 yagis and will be listening during the SK2GJ tests.

GW3XYW: Stu reports good conditions. On the 25th he worked SM2GGF (449), DL7YCA (449), ZE5JJ (339) and DJ9DL (0) for initial #42. Nil was heard during his sked with K9KFR. K4QIF (339) was called on random with no reply and G3YGF was also copied (449).

DL9KR: Jan continued his excellent success. On October 21 he worked DL7QV (M/M) for initial #78. On the 24th he QSO'd JA8QQ (0/449) for #81, JA9BOH (449/449) and I5MSH (55/45) on ssb. On the 25th he worked W5UKQ (449/329) for #80, K5JL (559/559), G3WDG (459/559), G4KGC - YF G3WDG (439/0) for #81, W7GBI (549/559), W6ABH (559/459), W8YZS (559/449) for #82, WB0TEM (45/55) on ssb, W0RAP (0/0) for #83, WB5LUA (449/0) and JA9BOH (459/449). On the 26th no new QSO's were made but SM2GGF and DL7QY were heard. On the 7th at 0600 W1UHE was copied (0) but only (T) was heard in reply.

SM2GGF: Vidsel worked on October 24/25th JA9BOH (339/449), G3YGF (0/0), GW3XYW (339/449), WB5LUA (0/0), W6ABN (0/0), K2UYH (0/0), W0YZS (00) and JA9BOH (339/449). Stations heard include JA6CZD, I5MSH, DL7YCA, G3WDG, ZE5JJ, DL7KR, K4QIF and W7GBI.

OK3CTP: On October 24 Jan QSO'd JA9BOH (M/0), G3YGF (0/0), GW3XYW (339/449), WB5LUA (0/0), W6ABN (0/0), K2UYH (0/0), W0YZS (0/0) and JA9BOH (339/449). Stations heard include JA6CZD, I5MSH, DL7YCA, G3WDG, ZE5JJ, DL7KR, K4QIF and W7GBI.

OH3TH: Peter writes that he could not be QRV during the October weekend because of a snowstorm with very high winds, but expects to be operational in November. He did listen for SK2GJ with two loop yagis, but heard nothing. On October 4 he worked at 1005 DJ8QL (0/0) for initial #37 and on the 25th at 1135 (IARU contest) DL7YCA (439/449).

ZE5JJ: We now have Peter's September report, but not his October one. During the September weekend he worked DL9KR (12 dB 0/0), JA6CZD (12 dB 0/0), OH3TH (6 db 0/0), DJ9DL (6 dB 0/0), DL6WU (3 dB M/0), DL7YCA (6 dB 0/0), OK3CTP (6 dB 0/0), KA0Y (18 dB 0/0), K0VXM (6 dB 0/0), VE4MA (6 dB 0/0) and K5JL (6 dB 0/0).

JA4BLC: Yoshiro was also troubled by bad weather and local power line noise and made no QSO's. He did copy KA6Y (0), K2UYH (0) and JE6CTS (T) during breaks in the noise. Yoshiro reports that Aki, JA1VDV is still in the hospital, but now in much better health and that he should have left the hospital in December. To make use of his time Aki has been working with a microcomputer.

VK3ATN: Ray now has a 28 foot dish working with a very limited window. He points his dish by moving the feed. At present his moon window is from GHA 207 to 227 degrees with a maximum north declination of 8 degrees. This arrangement does not allow a common moon window with North America, but he is considering moving his mount. For receive he is using a 35K97 preamp with around a 1 dB NF and is seeing in excess of 18 dB of sun noise. He has copied ZL3AAD during tests. For transmit he has 150 watts and wants to locate a KW final. Ray is especially interested in a second hand RIW final at a reasonable price. Can anyone help? Ray maintains a regular sked with W2IMU on Friday mornings at 1200 Z on 14.150 MHz.

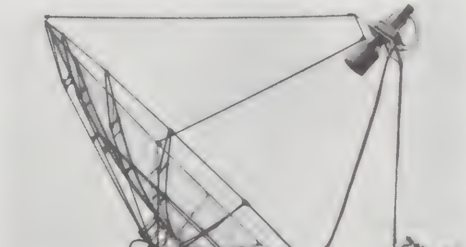
W7GBI: Charlie has his 25 foot dish working as testified by numerous reports of his increased signal strength. On October 21 he made his first dish QSO with K2UYH (449/449), on the 23 he worked W1JR (0/0), W5UKQ (M/M) for a new state and KA0Y (56/54) on ssb. On the 24th he QSO'd W1XP (0/M) and on the 25th G3YGF (0/0), W6ABN (0/0) and DL9KR (559/549). XE1RY was heard (M) on sked, but disappeared. Nil was heard from W1UHE. On the 27th HB9BPQ was worked (M/M) after a long try and on the 28th he worked I5MSH (449/449) and W6ABN (449/339). On the 29th he made it on for the Arecibo tests, working NP4A (57/59) on ssb.

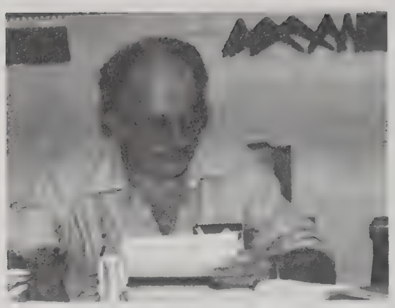
W1UHE: During the October skeds Norm worked KA0Y (M/M) and exchanged (M/M) with G3WDG, but does not think they copied his final R's. Nil was heard from WB0TEM and DL9KR only (T). On the 29th he was on for the Arecibo tests and worked KP4EKA (55/559). Norm also listened for SK2GJ with a 38 el loop yagi and NE645 preamp, but does not believe that he was listening at the right times - weather was very poor. He did hear some unidentifable cw at one point.

W1JR: Joe worked on October 23 at 0145 W7GBI on random, but had no luck in skeds with K4GL. Earlier in the month he worked WB0YSG for a new state. On the 25th he worked at 0019 ZE5JJ, 0206 DL7YCA (unbelievable signal) and 0253 OK3CTP. Also called were DL7QY and DJ9DL both (0), but they only responded with QRZ's. VE1OD was heard with an fb signal. JA9BOH was heard at 1145. On the 29th Joe worked WA3FET/KP4, NF4B and KP4EKA - all on ssb.

K2UYH: On October 21 we ran with W0RRY exchanging (0/0) but did not complete a QSO because of problems at Charlie's end. After the sked at 0420 W7GBI was worked (449/0) and heard (23) on ssb with his new dish. We tried again with W0RRY on the 22nd at 0357 and QSO'd (0/0). At 0420 we worked W7GBI again (449/559). On the 25th we QSO'd at 0337 DJ9DL (339/439) with QRM problems, 0430 DL6WU (439/339) for initial #145, 0455 DL7QY (339/439 for #146, 0600 nil from SM5CPD, 0615 W6ABN (439) lost, 0625 I5MSH (44/45) on ssb, 0707 SM2GGF (0/0), 0724 KA0Y (55/56) (Ken reported a partial with DL6WU and QSO's with WB0TEM, W0RRY and WA7BBM on ssb.), 0745 K0TLM (42/45) on ssb, 0800 K4GL nil, 0830 WB0YSS nil (W1UHE heard with good sigs), 1030 JE6CTS partial (0/T), 1100 JA8QQ nil, 1128 JA9BOH (449/449), 1145 JA6QXO (44/44) on ssb and 1200 QRX - lost. Early in the evening W5UKQ was heard and called. The next night the weather turned foul and we did not dare untie our dish to participate in the 1296 skeds.

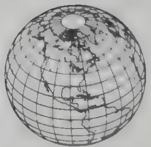
Shown to the left is the VE7BBG dish with a horn for 1296 MHz mounted in place. The photo was taken in September of 1979.





G3IOR

Worldwide Satellite Activity



*By Pat Gowen, G3IOR**

The past few months have indeed been very quiet on the satellite modes, with the lure of easily accessible DX on the hf bands, contrasting with the severe attenuation on the satellite signal caused by the same high muf's. Very few new countries are in evidence to enable those on the verge of DXCC-OSCAR to accomplish the feat, although lots of new stations in already established areas have been active seeking contacts, plus the usual regulars still hard at it after many years of activity.

The very high ion concentrations around the North aurora zone this Fall equinox brought in some exciting phenomena, with the first cross-band 6 meter to 4 meter QSO between VE1ASJ and G4BPY across the Atlantic, 2 meter QSO's right across the North American continent between VE3 and W6, and the ZS6PW 2 meter beacon heard in England by G8PON. Our satellites shared in the improved propagation by permitting access well below horizon at times, but the 10 meter downlink suffered badly, frequently being only RST 21A above horizon, but much stronger and clearer when well below theoretical audibility.

Excellent signals were heard from W5VVR, K5ADQ, WA5ZIB, N6DD, W6DWN, W7MKW, W7UFE, W7FF, and a whole lot more long after the European uplinks failed to access on Mode A. In the mornings, the JA's could be heard well before AOS time, sometimes to disappear only seconds before access was possible. Under these conditions, the old adage "if you can hear'em, you can work'em" is certainly not always true, and it can be a very frustrating experience to hear someone calling you just a few seconds after your own signals have dropped out. Bob, G6RH, made the most of the sub-horizon access, and was rewarded with QSO's with W5VVR, WA5ZIB (Texas) and Nikki, K5ADQ (New Mexico!) Your scribe, unfortunately, is in an ultra-QRL situation from the beginning of October until Christmas, and rarely able to get to the rig until long after the ideal daylight passes have gone!

GM4IHJ has been active on Mode J exploring the SDX phenomena. On 21 September 1980 on a 231°W EQX at 1232 he heard W4AUZ in Kentucky, and tried to work him with signals at RS54 and 42 respectively, but without success, until LOS at 1224 UTC. That orbit was theoretically far too East of the USA for normal access, but the explanation came from Vic, W1NU via WA3NAN the same evening, when he reported that the "Bermuda High" had given both 2 m. and 70 cm. contacts between VP9 and W1 and 2. It apparently also significantly aids Mode J SDX! As the "Bermuda High" is a punctual late September feature, we can be ready for 1981.

OSCAR Listings

Station	*Continents*	*Countries*	*Stations*	*Modes*	*Best DX*	*QRB*	*Points Total*
G6RH	5	92(88)	2189	A, B	PY7APS/1	9200km	27,740
G3IOR	5	114(108)	2000	A, B, J	W6CG	9570km	26,950
OK3AU	4	107(97)	2042	A, B	?	?	26,770
W0CA	6	62(58)	1198	A, B	CN8AK	8486km	16,580
VE2LI	5	101(50)	1500	A, B, J	UA0LBN	?	21,300
HB9AOF	5	52	648	A, B	FY7AS	?	10,330
AA6XI	5	18(?)	485	A, B	JA8DXB	?	7,100
VE3EFX	3	30	478	B only	OE3JBC	6800km	6,930

Active Rarer Countries Listing "SDX"

Station	*Usual Downlink Freq.*	*Mode*	*Remarks*
UW4NI	29.430/145.930	cw only	Excellent operator with good sig. and Rx
Y23FG	145.955	ssb	Active operator sometimes on cw also
YO9CN	435.150	cw only	Also active on 'B' and 'A' modes
SU1CR	29.463	cw	Fairly QRS
CO2JA	145.950 ±	cw	Jose now on 'B' as well as 'A'
NL7F	29.450	cw	Excellent signal in Eu. from Alaska
UT5DL	29.430/145.930	cw	Now on 'B' as well as 'A' Old MS op
SV0AP	29.450/145.950	ssb	First activity from Crete
UT5BN	29.430	cw	Not often QRV
UA0SBI	29.435/145.935	cw	Oldtimer on 'A', new to 'B'
UA0SBJ	145.940	cw	New one from Siberia on 'B' QRP
VE8CM	435.150	cw	N.W.T. now on 'J' as well as 'A' and 'B' modes
SV1IW	29.450	ssb	Counts as Greece, active 19-2100
GW8IA	29.450	ssb	Usually on around 2100 UTC
GJ8EZA	29.450/60	ssb	Good signal from Jersey
CT1WW	145.955	ssb	Now on 'B' as well as 'A' mode
CT4KQ	29.455	ssb	Mainly QRV OSCAR 8
GI5SJ	145.940	cw	Often on 'A' cw also
UA4NDX	29.455	ssb	Strong A-O 8 signal

**17 Heath Crescent, Hellesdon, Norwich, Norfolk, NR 66 ND, England.*

Satellite Log

By Geoffrey Falworth*

Satellite Log features launches into orbit since the beginning of 1980. The satellite name is that assigned by the launching agency (the international designation is in parenthesis) and the orbit (period, inclination to Earth's equator, apogee height, perigee height) is for shortly after launch; later maneuvers may modify this orbit. Transmissions are those which are publicly reported or assumed from the type of spacecraft involved.

Cosmos 1199 (1980-58H) launched on 1980 Jul 9; initial orbit: 115.01 min, 74°.01, 1478 km, 1433 km; transmissions: none reported. Military communications satellite.

Cosmos 1200 (1980-59A) launched on 1980 Jul 9; initial orbit: 89.53 min, 72°.83, 302 km, 199 km; transmissions: none reported. Recoverable reconnaissance satellite.

Ekran 5 (1980-60A) launched on 1980 July 15; initial orbit: 1419.98 min, 1°.97, 35684 km, 35266 km; transmissions: 702 to 726 MHz, 714.000 MHz. Television relay satellite.

Cosmos 1201 (1980-61A) launched on 1980 Jul 15; initial orbit: 89.12 min, 82°.33, 247 km, 212 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Rohini Satellite 2 (1980-62A) launched on 1980 Jul 18; initial orbit: 96.85 min, 44°.75, 919 km, 305 km; transmissions: none reported. Indian test satellite.

Molniya 78 (1980-63A) launched on 1980 Jul 18; initial orbit: 736.58 min, 62°.79, 40818 km, 457 km; transmissions: 3650 to 3700 MHz, 3750 to 3800 MHz, 3850 to 3900 MHz. Molniya 3-class communications satellite.

Soyuz 37 (1980-64A) launched on 1980 Jul 23; initial orbit: 89.06 min, 51°.58, 272 km, 190 km; transmissions: 20.008 MHz, 121.750 MHz. Manned spacecraft (crew: Viktor Gorbatko, commander and Pham Tuan, flight engineer) docked with Salyut 6 at 2002UT on 1980 Jul 24.

Cosmos 1202 (1980-65A) launched on 1980 July 24; initial orbit: 89.47 min, 72°.84, 297 km, 198 km; transmissions: 19.988 MHz. Recoverable reconnaissance satellite.

Cosmos 1203 (1980-66A) launched on 1980 Jul 31; initial orbit: 89.36 min, 82°.32, 270 km, 213 km; transmissions: none reported. Recoverable reconnaissance and Earth resources satellite.

Cosmos 1204 (1980-67A) launched on 1980 Jul 31; initial orbit: 93.35 min, 50°.66, 538 km, 345 km; transmissions: none reported. Radar interception and calibration satellite.

Cosmos 1205 (1980-68A) launched on 1980 Aug 12; initial orbit: 89.57 min, 72°.82, 306 km, 199 km; transmissions: 19.989 MHz. Recoverable reconnaissance satellite.

Cosmos 1206 (1980-69A) launched on 1980 Aug 15; initial orbit: 97.37 min, 81°.19, 633 km, 631 km; transmissions: none reported. Military weather satellite.

Cosmos 1207 (1980-70A) launched on 1980 Aug 22; initial orbit: 89.30 min, 82°.29, 265 km, 213 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Cosmos 1208 (1980-71A) launched on 1980 Aug 26; initial orbit: 89.58 min, 67°.16, 328 km, 180 km; transmissions: none reported. Recoverable reconnaissance satellite.

Cosmos 1209 (1980-72A) launched on 1980 Sep 3; initial orbit: 89.83 min, 82°.34, 271 km, 258 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Meteor 36 (1980-73A) launched on 1980 Sep 9; initial orbit: 102.40 min, 81°.25, 894 km, 848 km; transmissions: 137.400 MHz. Weather satellite.

Goes 4 (1980-74A) launched on 1980 Sep 9; initial orbit: 1436.12 min, 0°.19, 35809 km, 35777 km; transmissions: 468.850 MHz, 1681.600 MHz, 1684.000 MHz, 1687.100 MHz, 1688.200 MHz, 1690.200 MHz, 1691.000 MHz, 1694.000 MHz, 2209.086 MHz, 2214.000 MHz. Geostationary operational environmental satellite over longitude 98° West.

Soyuz 38 (1980-75A) launched on 1980 Sep 18; initial orbit: 88.95 min, 51°.60, 256 km, 195 km; transmissions: 20.008 MHz, 121.750 MHz. Manned spacecraft (crew: Yuri Romanenko, commander and Arnaldo Tamayo Mendez, researcher-cosmonaut) docked with Salyut 6 on 1980 Sep 19.

Cosmos 1210 (1980-76A) launched on 1980 Sep 19; initial orbit: 88.76 min, 82°.29, 244 km, 180 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Cosmos 1211 (1980-77A) launched on 1980 Sep 23; initial orbit: 89.11 min, 82°.35, 242 km, 216 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Cosmos 1212 (1980-78A) launched on 1980 Sep 26; initial orbit: 89.03 min, 82°.35, 245 km, 205 km; transmissions: 19.989 MHz. Recoverable reconnaissance and Earth resources satellite.

Progress 11 (1980-79A) launched on 1980 Sep 28; initial orbit: 88.79 min, 51°.62, 247 km, 189 km; transmissions: 166.000 MHz, 922.750 MHz. Cargo and supply spacecraft; docked with Salyut 6 on 1980 Sep 30.

Cosmos 1213 (1980-80A) launched on 1980 Oct 3; initial orbit: 89.69 min, 72°.87, 289 km, 279 km; transmissions: none reported. Recoverable reconnaissance satellite.

Raduga 7 (1980-81A) launched on 1980 Oct 5; initial orbit: 1436.00 min, 0°.34, 25823 km, 35753 km; transmissions: 3675 MHz, 3775 MHz, 3875 MHz, 7250 to 7750 MHz. Communications satellite at Statsionar 3 location over longitude 85° East.

Cosmos 1214 (1980-82A) launched on 1980 Oct 10; initial orbit: 89.69 min, 67°.15, 346 km, 173 km; transmissions: 19.989 MHz. Recoverable reconnaissance satellite.

Cosmos 1215 (1980-83A) launched on 1980 Oct 14; initial orbit: 95.12 min, 74°.04, 550 km, 498 km; transmissions: none reported. Electronic surveillance satellite.

Cosmos 1216 (1980-84A) launched on 1980 Oct 14; initial orbit: 90.29 min, 72°.87, 379 km, 198 km; transmissions: 19.989 MHz. Recoverable reconnaissance satellite.

Cosmos 1217 (1980-85A) launched on 1980 Oct 24; initial orbit: 718.09 min, 62°.92, 39767 km, 606 km; transmissions: 2292 MHz. Early warning satellite.

Cosmos 1218 (1980-86A) launched on 1980 Oct 30; initial orbit: 89.73 min, 64°.89, 353 km, 171 km; transmissions: none reported. Recoverable reconnaissance satellite.

Fleetsatcom 4 (1980-87A) launched on 1980 Oct 31; initial orbit: 1428.20 min, 2°.50, 36234 km, 35433 km; transmissions: 244 to 270 MHz, 2252.500 MHz, 2262.200 MHz. Communications satellite leased to U.S. Navy to be located over longitude 172° East.

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AMSAT News

AMSAT gratefully acknowledges the hundreds of donations made by our members since May 23, 1980.

Tom Clark, W3IWI, receives a NASA Exceptional Performance Award

Dr. Tom Clark, W3IWI, President of AMSAT has received a NASA Exceptional Performance Award for inspired leadership, science, and engineering of the Mark III VLBI system which has produced the most accurate system in existence for large scale global geodetic measurements.

Dr. Clark has been the VLBI scientist and Mark III system engineer in charge of all aspects of the development since the start of the Mark III VLBI system development in 1974. The development team he assembled consisted of people from GSFC, Haystack Observatory, MIT, National Radio Astronomy Observatory, and SAO. He directed the design of a total system consisting of field station equipment and software, central correlator data processing facility, and an advanced data management/data analysis facility. In addition to developing the overall system design, Dr. Clark and his GSFC group developed in full detail the computer data handling/control part of the field station equipment and several station modules; designed the advanced data base system; and significantly advanced the technology with their development of the analysis system with improved models, algorithms, programs, and interactive configuration design. By taking the total systems approach, Dr. Clark not only produced a significant technology advance in the instrument, but also produced significant advances in the analysis systems to take full advantage of the new capability. As a result, the initial measurements with the Mark III system demonstrated a determination precision which was 70 percent better than the design goal.

Minutes of AMSAT Board Meeting

A meeting of the AMSAT Board of Directors was held on November 8, 1980 at the NASA Goddard Space Flight Center, Greenbelt, MD. The following people were in attendance (for part or all of the time): John Browning, W6SP*, Tom Clark, W3IWI*, Dick Daniels, W4PUJ, Dick Jansson, WD4FAB, Jan King, W3GEY*, Bob Myers, W1XT, Vern Riportella, WA2LQQ, Roy Rosner, K4YV, Martha Saragovitz, Bill Tynan, W3XO, Harry Yoneda, JA1ANG*, Will Webster, WB2TNC*, and Rich Zwirko, K1HTV*. (*Board Member)

A lengthy discussion on fund-raising techniques was led by Tom Clark. Suggestions included the selling of trinkets, offering of equipment to large donors, placing of ads in various magazines that would donate space and an appeal by the ARRL to its members. The consensus was that, although the plans look promising for the long-range, the financial requirements for the first half of 1981 are of concern and require immediate attention.

The future of *ORBIT* Magazine was then discussed, and since Joe Kasser, G3ZCZ, Editor of *ORBIT* Magazine was out of the country, a tape was played that shared his feelings on the future of *ORBIT.* Rich Zwirko moved that *ORBIT* continues in its present format through 1981 (*i.e.* a magazine rather than a newsletter). The vote was four in favor and two opposed (W3GEY and WB2TNC). Continuing with the discussion, Jan King moved that the Board adopt and agree to a budget on *ORBIT* and that legal counsel executes a contract with Ethan Allen Printers. The vote on this action was unanimous. Keeping with this train of thought, Rich Zwirko moved that the budget for *ORBIT* for the calendar year 1981 should not exceed $30,000 total. This would, however, exclude the postage costs for non U.S. members. All Board members unanimously approved. Bob Myers, Managing Editor of *ORBIT,* gave an analysis of methods to increase the circulation of the magazine. After some discussion, Rich Zwirko moved to authorize Ethan Allen Printers to continue the detailed planning of the mailing of a copy of *ORBIT* Magazine to every licensed amateur in the U.S. over the course of 1981 on a no-cost basis to AMSAT. Implementation of this plan will require Board approval. The vote was five in favor and one opposed (WB2TNC).

A summary of the 1981 budget for Membership and Administration was presented by Martha Saragovitz. Projected operating costs will be approximately $50,000.

Jan King wrapped up the meeting with a detailed review of AMSAT projects. This discussion included Phase III, UoSAT and SYNCART. Budget items on all three projects were discussed.

UoSAT: Vibration tests are Successful

The spaceframe for UoSAT successfully underwent vibration tests during the week of November 17-21, 1980. The satellite frame was vibrated and qualified to flight standards. All is thus in readiness for the next stage in the construction of UoSAT, the first Radio Amateur Scientific Satellite, and the next candidate for the post launch title of AMSAT-OSCAR 9.

Life Members

AMSAT gratefully acknowledges donations of $200 or more from the following new Life Members.

Donald Campbell, VE4NI
Marc Geeroms, ON7GF
Kenneth Miller, K6IR
M.W. Empsten, ON4ZN
William L. Bittenbender, KA6IAR
Edgar Mueller, YV5ZZ
David Henderson, VK2VAV
Hugh Brand, 6Y5HB
Antonio Fumagalli, I2FUM
Tiziana Borella, I2ZFN
Zovi Lino Dai, I3ZFC
Dick Gaul, K2GMY
J.A. Bell, ZL1ASQ
Andy Deskur, KA1M
Yair Shalgo, 4X4GI
Roy Foote, N7AIF
Iliya Jazic
Charles Sottile, WA2EGT

Best of *OSCAR NEWS* Published

OSCAR News is the publication of the AMSAT group in Great Britain. The Best of *OSCAR News* is a reprint of the better articles that have been published in *OSCAR News* over the last few years. The booklet may be obtained from AMSAT-UK, Secretary, Ron Broadbent, G3AAJ, 94 Herongate Rd, Wanstead Park, London E12 5EQ. Price - Direct Airmail $7.50 or £3.00.

IRC's Available

AMSAT has a large number of IRC's. IRC's are useful for prepaying the return postage for overseas QSL cards, but are expensive.

AMSAT will send you 40 IRC's in return for a $15.00 donation, which is less than that amount of IRC's would cost at the post office.

Write AMSAT-IRC, P.O. Box 27, Washington, DC 20044.

Launch Date Set for Phase IIIB

Once again Phase III has a date with destiny. ESA has informed us that Phase IIIB is currently scheduled to ride into orbit together with the European Communications Satellite and Max Plank Institutes' "Firewheel" on February 24, 1982. This will be the L7 vehicle, and is thus an operational not an experimental launch.

The Causes of Launch Failure at Kourou

*By Alexander Schoening, DC7AS**

Many reports about the failure of the ARIANE L02 launch have been published by the ESA (European Space Agency) since the 23rd of May 1980.

Even shortly after the failure of the launch a record was made public about the events that happened in the span of time between the ignition of the engines and the destruction of the vehicle 108 seconds later. This record has been published[1] and was later supplemented in ESA publications in more detail and by the events observed.[3]

The D engine which plunged into the sea with the rest of the rocket from an altitude of about 25 kms, was found about 5 kms to the south of the *Iles du Salut* on the 16th of June 1980 and retrieved from the sea. The remains of this engine were taken to Messrs. SEP in Vernon (France). At this place photographs of the remnants were taken. Fig. 1 shows the turbo-pump of the Viking-V-engine D, whereas Fig. 2 shows the injector and the dented lower exhaust-gas part of the engine.

ESA gave an account of the first preliminary results of the examination of the engine D in a press-release[2] in June 1980. Therein it is stated that many assumptions regarding the cause of the failure of the launch could be rejected and that only three hypotheses should be taken into consideration:

1) A first examination revealed in particular the presence of an identification label in the engine in the vicinity of the N_2O_4 injection orifices. ESA declared later[3] that it was clearly proved that the plastic tag in question had never come into contact with nitrogen tetroxide. Obviously it was flushed there only after the destruction of the engine. Furthermore, an engine test reproducing this circumstance was carried out with satisfactory results. The tag was probably torn off and then sucked into the injector on splashdown.
2) Detailed analysis of the noise produced by the engines seems to show some difference compared with the results recorded during various ground tests in Europe. ESA rejects any hypothesis which may have appeared in the press that the stages of technical design of the exhaust-jet deflector located beneath the launcher may have been influenced by economic considerations. On the contrary, the design was a result of thorough studies and tests on an engine-fitted mockup carried out in Europe.
3) Certain characteristic parameters of the D engine start-up, such as the combustion-pressure built-up, show tolerances slightly greater than normal.

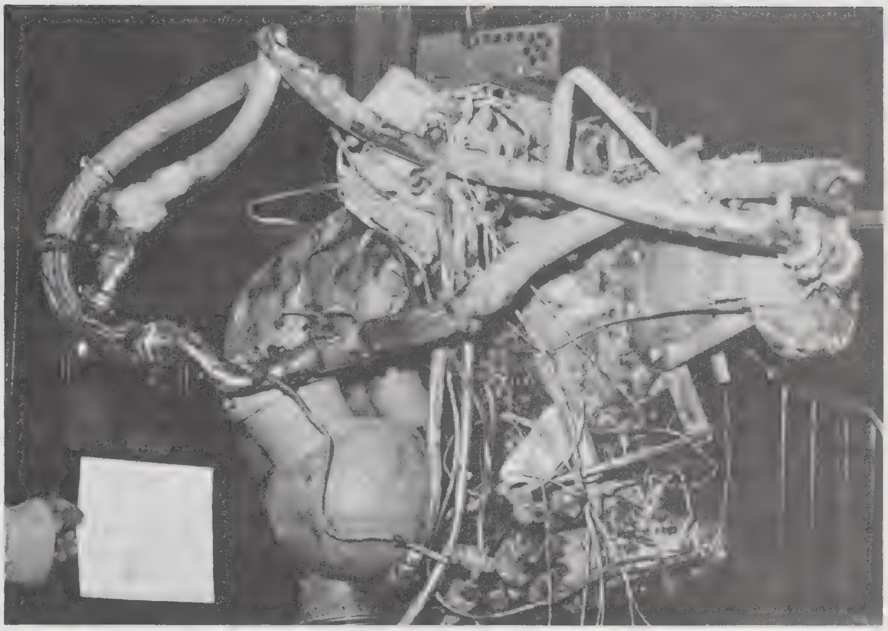


Fig. 1 — Remnants of the turbo-pump of the Viking-V engine "D" from Ariane L02.

During the summer of 1980, six working groups were busy trying to confirm or to eliminate the above mentioned hypotheses. They presented a detailed report[3] following additional studies, the contents of which is summarized in the ESA/*CNES* press-release No. 24 dated October 16, 1980. The following extracts are from this release:

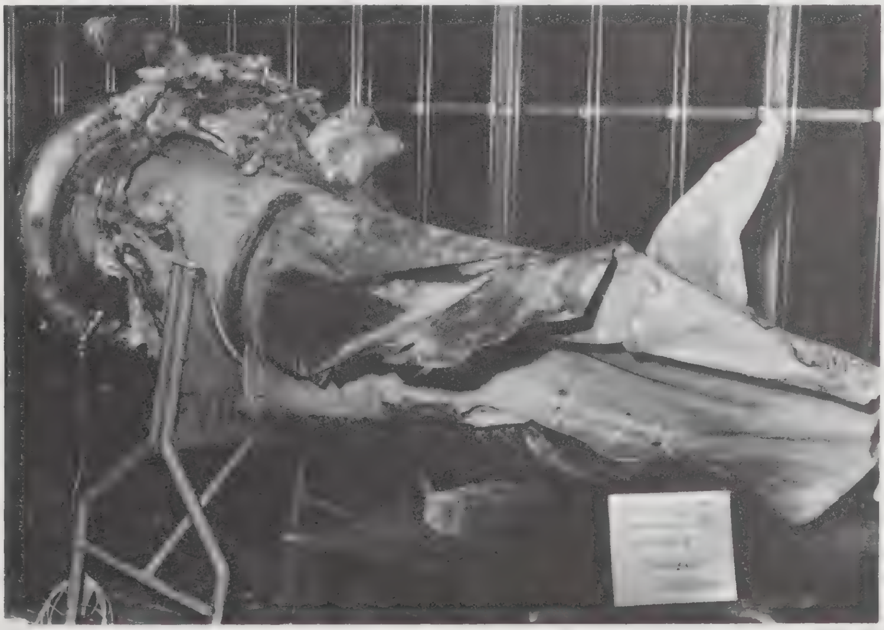
1) "The failure of the ARIANE L02 launch on the 23rd of May 1980 was due to combustion instability of a high frequency (above 2000 Hz) that occurred on one of the four first-stage engines 5.75 seconds after ignition."
2) "This extreme violent phenomena, lasting only 3/10ths of a second, abruptly altered the characteristics of the injector whose degradation led to the destruction of the engine 64 seconds after ignition. The fire that broke out after this in the propulsion bay caused the vehicle to be destroyed 108 seconds after lift-off."

The examination results (especially recent experiences concerning manufacturing tolerances of the injection nozzles) are to be considered on the occasion of the next test launch (L03 with METEOSAT) in the second part of March 1981. The last test Launch (L04) is scheduled for June 1981.

References

1. Werner Budeler, "*ARIANE L02 - Explosion und Absturz nach 108 Sekunden*," issue 2/1980, *Luft und Raumfahrt*, pages 56-57.
2. "ESA/*CNES* Press-Release" No. 17 dated June 24, 1980.
3. "Third Report on the L02 launch," ESA, Paris, October 15, 1980.

Fig. 2 — After splashdown: Injector and the dented lower exhaust-gas part of engine "D."



Ludolfingerweg, 52, 1 Berlin 28, West Germany.

“On the Question of Satellite DXCC. . .”

Last Spring the ARRL’s DX Advisory Committee (DXAC) recommended to their Awards Committee that QSOs made on the new Phase III type orbital satellites not be counted for credit toward the DXCC/Satellite (DXCC/S) Award. ORBIT *Editor Kasser, G3ZCZ/W3 recently interviewed AMSAT Executive Vice President Riportella, WA2LQQ, on the matter. The following report is an edited transcript of that interview.*

By Vern Riportella, WA2LQQ*

G3ZCZ: In the Sept./Oct. 1980 issue of *ORBIT* we published a letter from K4UAS. His letter criticizes both AMSAT and the ARRL for the decision on DXCC/S on a number of points, namely that members were not consulted, the timing is suspicious, the decision is unfair and member sentiment on issues should dictate policy in any case. What is your response to these points?

WA2LQQ: The first point concerns consulting members. The Phase III Operations Planning Committee held more than a half dozen meetings over a two year period. Under the direction of AMSAT Operations Vice President, K1HTV, the Planning Committee sought to chart the use of the Phase III Satellite. Announcements of impending meetings were made well in advance. Invitations to participate in person or by correspondence were broadcast on every occasion. Results of the meetings were published in the *AMSAT Newsletter*, bulletins were issued to the Nets and articles were published in various magazines including *QST*. All of this was done in a conscientious effort to keep members informed. So the impression that the Operations Planning Committee met in secret is false.

G3ZCZ: So why is it that hardly anybody knew of the decision until is was published in the June *QST*?

WA2LQQ: The timing of the announcement was unfortunate but unavoidable. The decision process began with the distribution of a Phase III population study. It was only when reviewing the results of that study that the Planning Committee recognized the true nature of the risks to the new satellite.

G3ZCZ: What risks?

WA2LQQ: Risks of severe degradation of the passband through very heavy QRM. Basically a very heavy use situation aggravated by power escalation and undisciplined operating practices. Taken together these factors are cause for concern.

G3ZCZ: When did these risks become generally known?

WA2LQQ: Mid-to-late Autumn 1979.

G3ZCZ: Why did the first announcement of the DXAC decision appear in *QST* in June 1980, then? And why wasn’t it announced in the AMSAT publication *ORBIT* Magazine?

WA2LQQ: Well, the DXCC/S award is an award issued by the ARRL. *They decide the rules on who gets it*, and they announce when the rules are changed just like they did in June. AMSAT’s role in this particular instance was that of an advisor. Several of us went to the DXAC, told them of our concerns with regard to the DXCC/S award and they took our recommendations under advisement. Their internal decision processes and the lead-time necessary to get something published in *QST* occupied the period from the time when AMSAT and other concerned parties made their recommendations in December 1979 until the June *QST* announcement. AMSAT was not aware of the decision in time to publish anything about it in the first issue of *ORBIT*.

G3ZCZ: Why has nothing appeared since in either *ORBIT* or *QST*?

WA2LQQ: Probably because it seemed a moot point after Phase IIIA took a bath on May 23. Yet you should note that since K4UAS and others have asked about the decision, we are attempting to show why the decision was necessary, moreover absolutely critical.

G3ZCZ: Could you summarize the first two points then.

WA2LQQ: Concerning consulting, all who participated in the Operations Planning knew that the risk of heavy QRM-damage to the mission of Phase IIIA was great. We moved as quickly as we could to avert a disaster. Given that the actual decision was not ours to make, we could hardly have announced it ahead of time. In short, the timing was unavoidable and given that timing, full and comprehensive consultation with the members was impossible. Finally, would a consultation have eliminated the risks?

G3ZCZ: Why didn’t AMSAT just wait until the QRM levels built to undesireable levels and then recommend discontinuing the DXCC/S for a while?

WA2LQQ: That might appeal to those who sought to complete their Phase II DXCC/S using Phase III but it has two basic faults. First, that would be impractical to do. Kind of like trying to put the genie back in the bottle. It would also be unfair to two groups. Those who made DXCC/S using Phase II only, the hard way so to speak, would justly complain that the challenge had been lessened since achieving DXCC/S on Phase III would be so easy. They would say we had changed the rules of the game. The other group who started their satellite activity on Phase IIIA would also justly complain that we had

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**Executive Vice President, AMSAT*

changed the rules by first allowing and then disallowing Phase III credit towards DXCC/S.

G3ZCZ: The next point concerns fairness. Is it fair that stations in the Northeast and Europe alone can make DXCC/S? Isn't the DXAC decision de facto guarantee of perpetuation of an unfair advantage?

WA2LQQ: I believe it is true that certain QTH's have advantages regardless of the type of activity engaged. This QTH is great for VHFing. That one for HF contest work since it sits on a swamp. The next one has some other inherent benefit. So I find it difficult to find the award unfair given that the nature of this type of competition is to do the best you can given the resources you have. It begs the issue of competition, don't you think, to say that the award is unfair because of the way political boundaries are established. Carried to its logical extremes, ARRL might be expected to issue a special DXCC for apartment dwellers who are disadvantaged by their inability to field large antenna arrays needed on 20 meters.

G3ZCZ: But don't you think one has a reasonable right to expect to complete his DXCC/S on Phase III?

WA2LQQ: When K4UAS began his quest for DXCC/S he was likely unaware of Phase III. He thus undertook a very rigorous challenge to do DXCC/S on Phase II, that is AMSAT-OSCAR's 6, 7 and 8 and the RS's. Did he expect to have the tremendous advantage of a high orbit satellite's coverage when he started? I think he did not. To now claim that it's unjust that Phase III contacts are not counted towards DXCC/S is to my mind like a marathon runner who rests at the 22nd mile post. While resting there he learns that someone has just invented the automobile. So he sits there waiting for a taxi to take him the last four miles. Worse yet, he cries foul when he learns that cabs don't stop on that block. Seems he forgot that the original objective was to run the 26 miles!

G3ZCZ: How easy will it be to make DXCC/S on a Phase III satellite?

WA2LQQ: If the Phase IIIB satellite becomes as popular as quickly as we think it will, within one year of launch one will be able to work in excess of 100 countries without leaving the operating position, that is, within a period of a few hours.

G3ZCZ: Is that capability generally known?

WA2LQQ: No, it's not. And that's one of the problems. People underestimate badly the communications potential of Phase III satellites. The orbit is not fully understood by the majority of potential users. If these factors were widely known, I believe that the ease of achieving a Phase III DXCC/S award would be obvious. It would then be concurrently obvious why a Phase III DXCC/S award makes a mockery of the DXCC as it is currently received.

G3ZCZ: Why is it that on the one hand you state that it will be possible to work 100 countires on Phase IIIB a year after launch and on the other hand not get a DXCC/S award for submitting QSL's for those 100 QSO's?

WA2LQQ: The decision by the DXAC is not a decision against working DX. It is a recognition that competition on the Phase III satellites is potentially very harmful to the successful accomplishment of their missions.

G3ZCZ: Is DXCC/S a contest? Is that what you're saying?

WA2LQQ: Of course it is a contest. But not a contest in the usual sense. It is competition against an arbitrary goal. A contest is usually against another station or group of stations. The DXCC/S is called an award. The *CQ* WW DX test is a contest. Both are forms of competition. The DXCC/S decision implies that the competitive atmosphere which inevitably accompanies the pursuit of DX stations whether for awards or a contest is not conducive to the discipline and cooperation necessary to operations within a tightly packed passband.

G3ZCZ: K4UAS believes that the members should decide policy.

WA2LQQ: In fact they do to a large extent. In the areas where policy is dictated by technical constraints or fundamental laws of nature, there are few degrees of freedom. We very often find many members are happy to have the directors and technically qualified officers make the decisions that need to be made for the best long-term interest of the organization since most policy decisions concerning spacecraft operations also have technical aspects. For example, while the decision to leave AMSAT-OSCAR 8 in Mode A/J for Field Day might seem a matter of policy, it certainly has to be viewed as a technical decision as well. What will happen to the batteries? On that rare occasion when reasons for a certain decision are poorly understood and this is such an occasion . . . the decision rests with those who bear the responsibility . . . the accountability . . . to exercise their best judgement. For example, given the insight to the risks involved, an independent expert would conclude that concerning the DXCC/S decision, had we *not* acted, it would have been the highest form of irresponsibility.

G3ZCZ: Do you see any time when AMSAT can recommend an award for satellite operation? Will there ever again be contests on satellites?

WA2LQQ: Anyone who asserts contests on satellites should be permanently banned is out of touch, unfortunately. The present DXCC/S decision should be viewed as a moratorium on competition to be lifted once the period of highest risk has passed. We view the present and immediate future of the Phase III program as a hiatus in Phase III competition until enough band space can be made operational so that the damage to other vital services using the satellites will be negligible during a contest or other competition.

G3ZCZ: When will that be?

WA2LQQ: The decision for instituting a suitable Phase III satellite award depends on how quickly the user community grows, how the international amateur community develops skills in the use of Phase III satellites and so forth. If, for example, the user density on Phase IIIB grows more slowly and is more disciplined than expected, then the decision to remove the present discouragements from satellite competition could be made within a year of the launch of Phase IIIB.

G3ZCZ: What about the other satellites under consideration? Will they help avert the QRM problem you mentioned?

WA2LQQ: Beginning in about 2½ to 3½ years the Amateur Space program is really going to take off, to pun a bit. We are now building in addition to Phase IIIB, which has about 180 kHz of passband, the Phase IIIC satellite. In addition to the Mode B transponder on Phase IIIB and Phase IIIC, there is the possibility of another transponder on each. Using 23 cm to 70 cm, these Mode M transponders would provide nearly 800 kHz of bandwidth. Also we are now full speed ahead on the SYNCART satellite program that will add enormously to the available satellite spectrum. And there is still more on the horizon . . . such as linked satellites and digital satellites. All this available spectrum points quite clearly to the fact that the moratorium on competition on Phase III will be relatively short when viewed in the perspective of the history of amateur satellites. We are just beginning Phase III, the journeyman's rank in Amateur Satellite development. Phase I OSCARS were beacons to point the way, Phase II were transponders in low polar orbits, Phase III is transponders in high elliptical orbits. Phase IV, just around the corner with SYNCART, is the advent of geo-synchronous satellites. With all this going on and the rate of progress being made, the present difficulties in getting Phase III aloft and determining among ourselves how best to use the facilities will soon seem like the occasional swollen thumb of an apprentice carpenter about to become a journeyman. Contests and competition will be back, to be sure.

Comets

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Send your report to ARRL, AMSAT-OSCAR 8 Third Anniversary, Club and Training Department, 225 Main Street, Newington, CT 06111.

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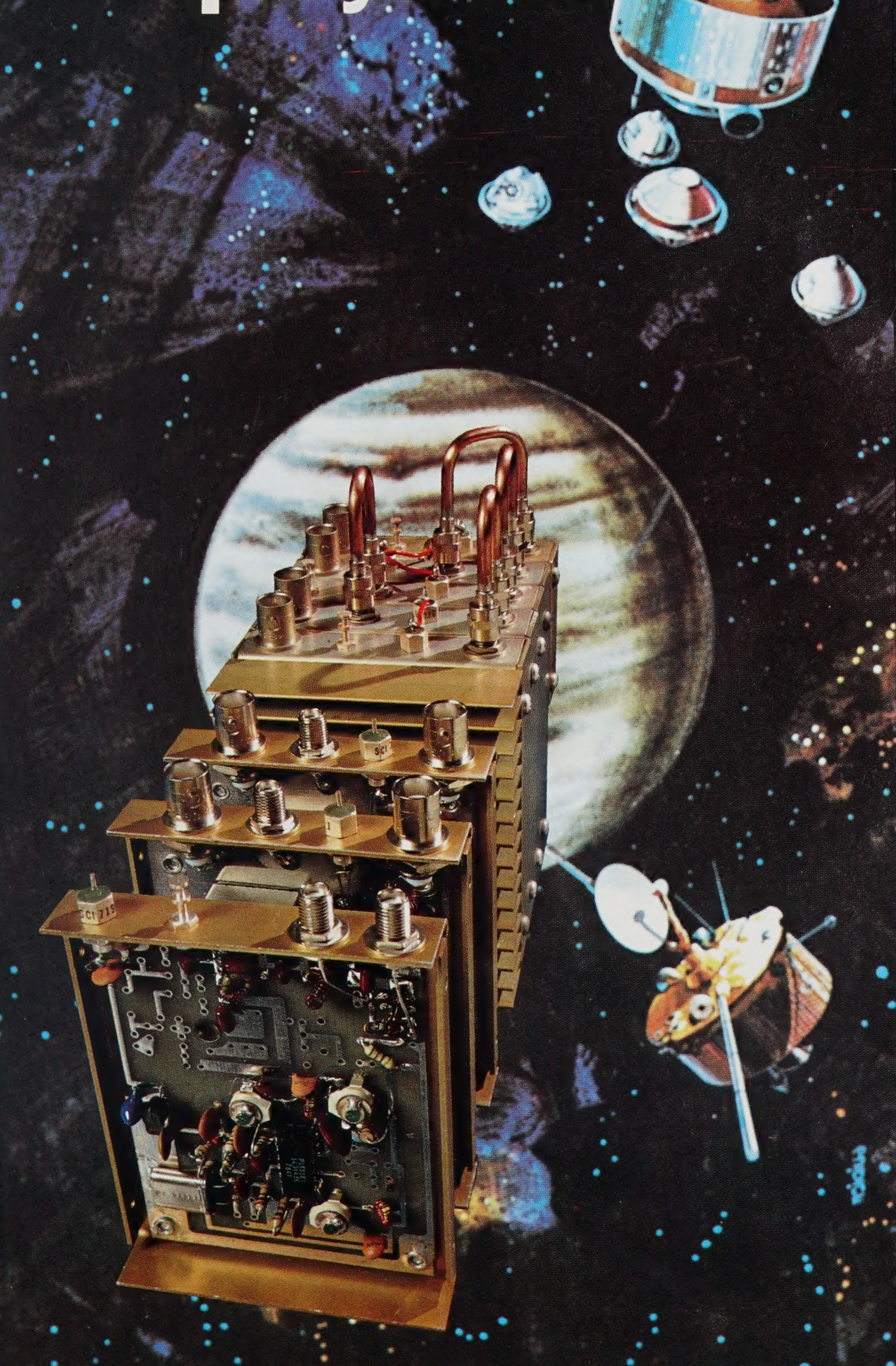

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Our transverter modules are distinctly different from the usual transverter or the home built transverter module. With the single band transverter you must purchase a different unit for each additional band you wish to cover.

Lunar's transverter modules, on the other hand, start with the basic down converter for receive and up converter for transmit. Selecting an appropriate local oscillator module determines the band. Additional modules are added to achieve desired receiving NF and/or output power. Changing the local oscillator module changes the band. Pre amps you already have or might build may be used as desired, similarly, for the transmit side.

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Some examples of expected performance using Lunar modules.

EXAMPLE 1

Selected modules:
DC 28
LO 28/144
UC-VHF
PAD 144
PAM 144

This combination gives you:
RF: 144 to 146MHz
IF: 28MHz to 30MHz
Conversion Gain: 25dB
Overall NF: 2 dB nom. 1.6 dB typical
Image Rejection: –30 dB typical
LO Purity: –50 dB max. all spurs & harmonics
Drive 28MHz: 1 to 5 mW
Power Output: 20 watts min.
Operating Voltage: 24VDC @ 2.5 amps. nom.

EXAMPLE 2

Modules added to Ex. 1
LO 28/220/222
PAM 220
PAD 220

This gives you:
RF: 220-222, 222-224MHz
Conversion Gain: 22 dB
Overall NF: 2.5 dB typ., 2.2 nom.
Other specs. remain the same.

If you have a specific band you'd like to cover, write or call us and we'll be happy to discuss it with you. Or send for our literature on transverter modules.

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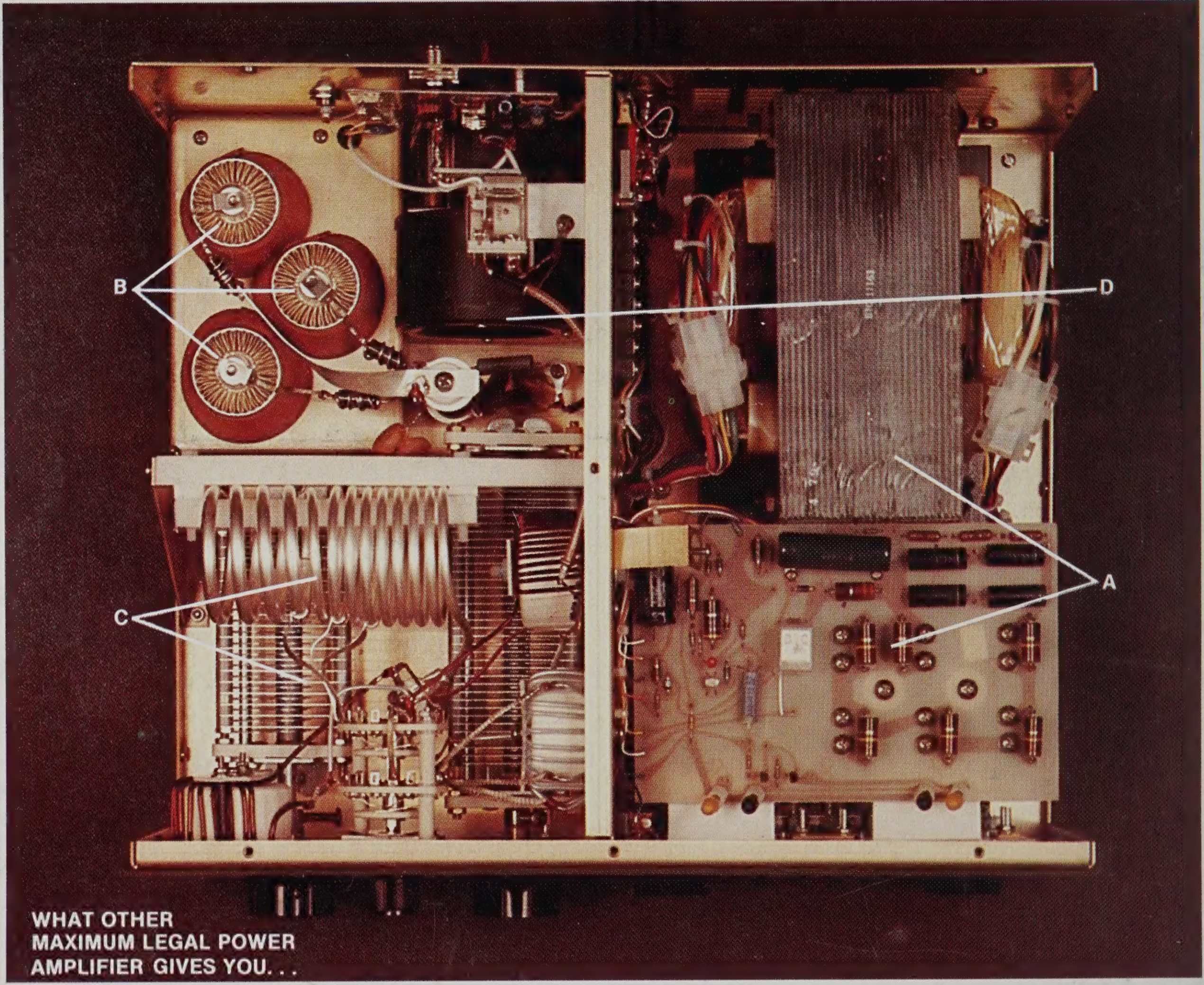

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